MODERN Machine Shop

HOWARD CAMPBELL, Editor

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CONTENTS

Page

MOTION AND PROCESS ECONOMY..... 9
By Myron A. Lee

CONVEYORS EXPEDITE PRODUCTION OF LYCOMING MOTORS.. 16
By W. H. Swink

THE FLEXIBLE SHAFT IN MACHINE DESIGN..... 26
By Geo. T. Latimer

STOREKEEPING AND LEDGERS ON GEAR JOBBING..... 40
By M. Zangrilli

IDEAS FROM READERS..... 50
—Press Tools for Corrugating Sheet Metal, By Charles Kugler
—A Handy Drill Extension, By David Fliegelman
—Hold-Down Fixture for Machining Tires, By D. D. Felter
—Boring Locomotive Valve Bushings, By Brent Cassell
—Machining Curved Surfaces in the Lathe, By Jos. Maslewski

"OVER THE EDITOR'S DESK"..... 56

NEW SHOP EQUIPMENT..... 58

INDEX TO ADVERTISEMENTS..... 94

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MODERN Machine Shop

CINCINNATI, OHIO VOL. 6, NO. 10

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Motion and Process Economy

Each extra movement made by a workman in the performance of a task costs his employer money. Yet very often an employer who is duly careful and economical in the purchasing of materials and equipment will allow his money to be wasted through lost motion in the manufacturing processes.

BY MYRON A. LEE

Professor of Industrial Engineering, Cornell University

A FEW years ago an article was published in "Factory and Industrial Management" under the signature of F. J. Van Poppelen, describing the work that had been done at the Cadillac Motor Car Company's plant in applying principles of motion economy. In the article Mr. Van Poppelen said "We felt that our greatest progress along the lines of good motion practice could be accomplished by making several hundred men in the organization 'motion minded' rather than by depending upon the results to be secured by some one man or by several men. We decided, therefore, to teach our superintendents, tool engineers, time study men, foremen, assistant foremen, and group leaders the principles of motion economy, and to demonstrate these principles and their application to specific operations with which they were more or less familiar."

This statement establishes the keynote of improvement of processes and operations by the application of the principles of motion economy. This is not a work in which only highly-trained time study men may participate; in fact, if a plant is to be successful in this undertaking, the foremen and assistant foremen should be interested and continually on the lookout for chances to apply the principles. There is nothing complicated about the principles of motion economy and anyone can apply them.

Simple Illustration of the Use of the Laws

A simple illustration of the application of some of the principles may best demonstrate this fact A manufacturing concern in one of its products used eight cap screws with a lock washer, plain washer and rubber washer under the head of each (see Fig. 1). It was found to facili-

tate assembly of the product if these washers were assembled on the cap screws. (The rubber washer fitted tightly enough so that it held the plain washer and lock washer on the cap screw.)

Original Method of Assembly

Originally the procedure for this sub-assembly was as follows: The

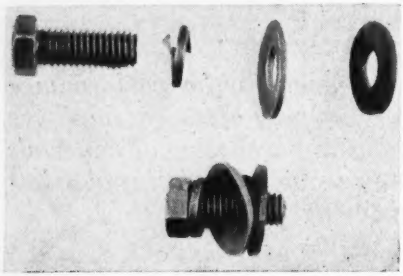


Fig. 1 — Capscrew with lock washer, plain washer, and rubber washer to be assembled together.

parts were placed in containers on a bench, the operator picked up a screw with the left hand and then, holding the screw in the left hand, picked up a lock washer and placed it on the screw, then the plain washer and then the rubber washer, deposited the assembly in a container and then repeated the procedure.

Improved Method of Assembly

A consideration of the principles of motion economy suggested the following method of assembly. The parts were placed in bins arranged approximately in a semi-circle about the work place (see Fig. 2). A very simple fixture illustrated in Figs. 2, 3 and 4 was constructed. This fixture consisted of a hardwood board shown in Fig. 3. Two counterbored holes (A and B, Figs. 3 and 4) were located as shown and a bent metal chute (C and D, Fig. 3) was attached to this board for drop delivery of the finished assemblies.

The procedure of assembly with this arrangement is as follows: Operator makes two assemblies at a time, one with each hand. The operations and motions of each hand are identical. Operator reaches to bin No. 1 and slides rubber washers to holes A and B, then reaches to bin No. 2 and slides plain steel washers to holes A and B, then to bin No. 3 and slides lock washers to holes A and B. Next a cap screw is grasped by each hand at bin No. 4 and inserted thru the washers in holes A and B. When the cap screws are lifted from holes A and B the washers remain on the screws because of the snug fit of the rubber washers. The assemblies are dropped in chutes C and D as the hands reach for rubber washers from bin No. 1 to repeat the cycle.

A very satisfying feature of most of these improvements is the very small amount of expense entailed in connection with the improvement. For instance, in this case a sheet metal bin was made which could be used for a variety of small assembly

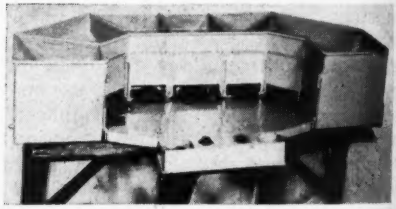


Fig. 2—Arrangement of parts according to improved method.

jobs. The fixture was only a hard wood board with two holes bored in it and a bent metal drop delivery chute. The time of the operation was reduced about 50 per cent.

This saving was occasioned by applying the following very simple principles of motion economy:

1. Originally the left hand was engaged mainly in holding the cap screw while the washers were assembled by the right hand. The fixture eliminated this holding, releasing the right hand for useful work.
2. The two hands in each case begin and end their motions at the same time.
3. Motions are in opposite and symmetrical directions.
4. Motions are rythmic.
5. Drop delivery has been provided for.
6. Materials have been located around the work place and close to the point of use.
7. Fixed stations have been provided for materials.
8. Gravity feed bins have been used for materials.
9. It has been made possible to transport the washers by sliding rather than by grasping and carrying.

FIGURE 3

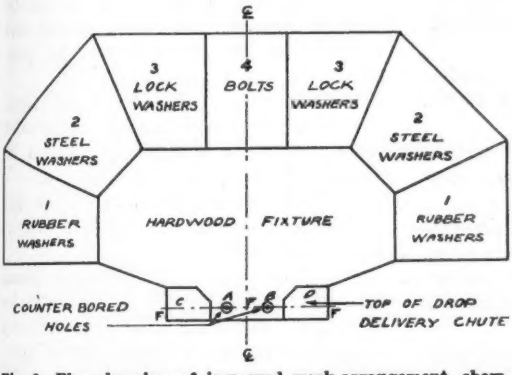


Fig. 3—Plan drawing of improved work-arrangement, showing distribution of parts, locating holes for bolts in process, and delivery chute.

Procedure in Applying the Laws of Motion Economy to an Operation

To apply the laws an operation is checked against the list of laws to see which laws are being partially or completely violated. Then a little ingenuity is used to rearrange the work place and procedure to conform to the laws which it is decided are applicable to the particular operation, continually bearing in mind of course that no unwarranted expenditure is to be made.

The Laws of Motion Economy

Since the term "therblig" is used in the statement of some of the laws, this term will first be defined and explained.

The word "therblig" is simply "Gilbreth" spelled backwards. The term was originated by Frank Gilbreth to save time. He explained that he coined it "for the purpose of having a short word which will save the motions necessary to write such a long description as 'one of the seventeen categories into which the motion study elementary subdivisions of a cycle of motion fall'." **(Gilbreth, F. B. and L. M. "Classifying the Elements of Work", Management and Administration, Vol. 8, No. 2, pg. 151, August, 1924).**

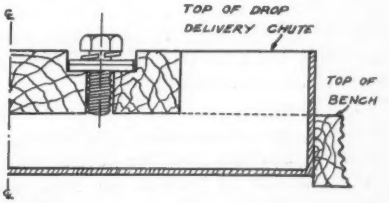


Fig. 4—Cross section of work bench through part F—F.

In other words, a "therblig" is a short or elementary motion such as "grasp", "release part", "transport part", etc. A series of such "therbligs" make up the cycle of motions

necessary to perform any given operation.

Gilbreth developed rules or laws for motion economy and fatigue reduction. These have been amplified by other workers in the field until now the recognized principles might be listed as follows:

1. The two hands should preferably begin their therbligs simultaneously.

2. The two hands should preferably complete their therbligs at the same instant.

3. The two hands should not be idle at the same instant except during rest periods.

4. Motions of the arms should be in opposite and symmetrical directions, instead of in the same direction, and should be made simultaneously.

5. Hand motions should, ordinarily, be confined to the lowest classification with which it is possible to perform the work satisfactorily.

6. Materials and tools should be located to permit the best sequence of therbligs.

7. Continuous curved motions are preferable to motions in straight lines where the latter require sudden and sharp changes in direction.

8. Free, loose (ballistic) movements are faster, easier, and more accurate than restricted (fixation) or controlled movements.

9. Rhythm is essential to the smooth and automatic performance of an operation and the work should be arranged to permit an easy and natural rhythm wherever possible.

10. Momentum should be employed to assist the worker wherever possible, and it should be reduced to a minimum if it must be overcome by muscular effort.

11. The hands should be relieved of all work which can be performed more advantageously by the feet or other parts of the body.

12. "Drop deliveries" should be used wherever possible.

13. Gravity feed containers and bins should be used to deliver the material as close to the point of assembly or use as possible.

14. Tools and materials should be located around the work place and as close to the point of use as possible.

15. Definite and fixed stations should be provided for all materials; tools, and light equipment should be prepositioned wherever possible.

16. Mechanical devices should eliminate the therblig "hold" whenever practicable.

17. The height of the work place and the chair should preferably be arranged so that alternate sitting and standing at work is easily possible.

18. A chair of the proper type and height to permit good posture should be provided for every worker possible.

19. Where each finger performs some specific movement, as in typewriting, the load should be distributed in accordance with the inherent capacities of the fingers.

20. Handles such as those used on cranks and screwdrivers should be designed to permit as much of the surface of the hand as possible to come in contact with the handle. This is particularly true when considerable force is exerted in using the handle.

21. Levers, hand wheels, crossbars, push buttons and handles should be so located that the operator can manipulate them with the least change in body position and with the greatest mechanical advantage.

22. It is usually quicker to transport small objects by sliding than by carrying.

23. A "full hook" grasp is usually quicker than a "pressure" grasp.

24. An effort should be made to establish standard times for the performance of various therbligs under standard conditions. These may then be used in setting "synthetic" times.

25. The number of therbligs required to perform a cycle should be ascertained, as the best method is usually that involving the fewest therbligs per cycle.

Application of the Laws

The first four laws may be considered together. Perhaps the best example of trying to disobey these laws is the time honored stunt of trying to pat your head and rub your stomach at the same time. These four laws were all violated in the original method of assembling the cap screw and washers. They were all observed in the improved assembly method. A very universal example of their violation is in the accepted method of drilling, tapping or countersinking small holes in parts using a single spindle sensitive drill. After studying these laws the American Hard Rubber Company built a small sensitive drill with two spindles about 5 inches apart. These spindles could be lowered simultaneously by pressing on a foot lever. The operator now grasps a part in each hand, positions the parts under the drill, and depresses both drills at once with the foot pedal. Here is an opportunity for some wide-awake drill manufacturer to improve his sales.

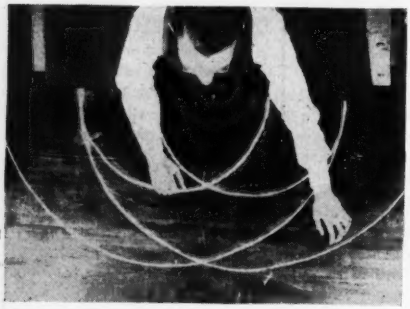


Fig. 5—Operations are classified by the arm movements required.

Law No. 5. Hand motions should ordinarily be confined to the lowest classification with which it is possible to perform the work satisfactorily.

The classification referred to in this law is as follows:

1. Finger motions.
2. Motions involving fingers and wrist.
3. Motions involving fingers, wrists and forearm.
4. Motions involving fingers, wrist, forearm and upper arm.
5. Motions involving fingers, wrist, forearm, upper arm and shoulder. This class necessitates disturbance of the posture.

Fig. 5 is a view of a work place looking vertically downward. If an operation can be arranged to be performed within the space included by the small semi-circles the motions required will be in class 3 or lower. If the operation can be arranged to be performed within the areas enclosed by the large semi-circles, the motions necessary will fall in class 4 or lower. Any portion of the operation requiring the operator to reach beyond the large semi-circles will involve a class 5 motion.

However, one feature of this classification should be borne in mind. In considering classes 1 and 2, it is a well established fact that motions of the wrist and forearm are easier, faster and usually more uniform than motions of the fingers alone. For this reason it is advisable in applying this law to avoid attempts to use finger motions only, when the use of wrist and forearm motions can accomplish the purpose. With this ex-

(Continued on page 86)

Conveyors Expedite Production of Lycoming Motors

By W. H. Swink

Production Engineer, Lycoming Manufacturing Co.

As told to
Francis A. Westbrook

THE production of a cylinder unit for an internal combustion engine is usually a somewhat lengthy and complicated job, involving from perhaps 25 to 45 machining operations. Thus it is easy to understand that a very large share of the process time is absorbed in moving the piece from one operation to another, or turning it over or around, or locating it properly for the tools on the subsequent operation. And unless means are provided for supporting the load between operations and turning it about mechanically, production will suffer due to the extraordinary fatigue induced by the handling.

The Lycoming Manufacturing Company builds internal combustion engines for automotive, aircraft and

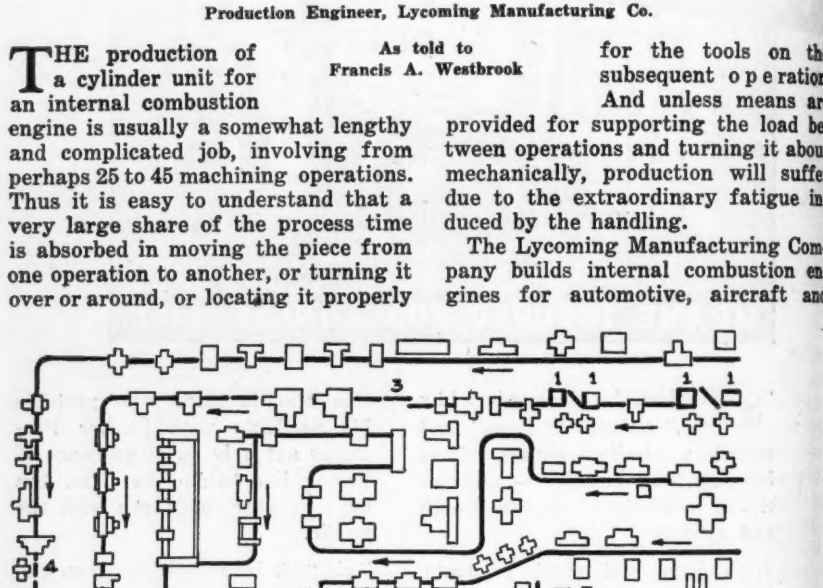


Fig. 1—Layout of cylinder department at Lycoming Manufacturing Company's plant, showing conveyor lines.

1. Turntable
2. Portable Turntable
3. Transfer Car
4. Small Turntable
5. Special Turnover Mechanism
6. Turnover and Lifting Stand
7. Transfer Car and Elevating Mechanism
8. Carrier-Type Chute
9. Hinge Mechanism
10. Shuttle Car
11. Turntable and Tilting Mechanism
12. Special Tilting Device

marine use. When the demand for their engines rose to a point that exceeded the production capacity of the plant recently, it became necessary to install a considerable amount of new machinery in the automotive cylinder block department. And in order to locate the new units properly, it became necessary to move so many of the existing machines that it was decided to re-set the entire line of machines and install a complete conveyor system, thus reducing the fatigue as far as possible, eliminating lost time resulting from manual handling, and increasing the safety factor for the operators.

In planning the system, turntables, transfer cars, and raising or tilting devices were provided wherever they could be used to advantage in lining up the blocks with the beds of the machines. The use of power hoists has been avoided except at the beginning of the line, where it is necessary to raise the block onto the conveyor in order to start it on its way. All of the conveyor sections are of the gravity-roller type, and are of an identical height excepting at a few points. The course of the conveyor is very clearly indicated on the plan layout of the department shown as Fig. 1.

The operators now working on the cylinder block production lines are with few exceptions the same men who worked on these operations before the new conveyor system was installed; thus it has been possible to obtain a very fair comparison between the production figures under the old system and under the new. It has also been interesting to note the difference in the attitude of the operators when it became apparent that their physical welfare was being taken into consideration. The most outstanding fact, however, consisted in that it would have been impossible to obtain the full benefit of modern, up-to-date machine tools and equipment if an equally modern material handling system had not been provided with which to serve them. The two are inseparable if maximum results are to be realized.

The elimination of fatigue is, of course, one of the more important of the advantages of the conveyor system.

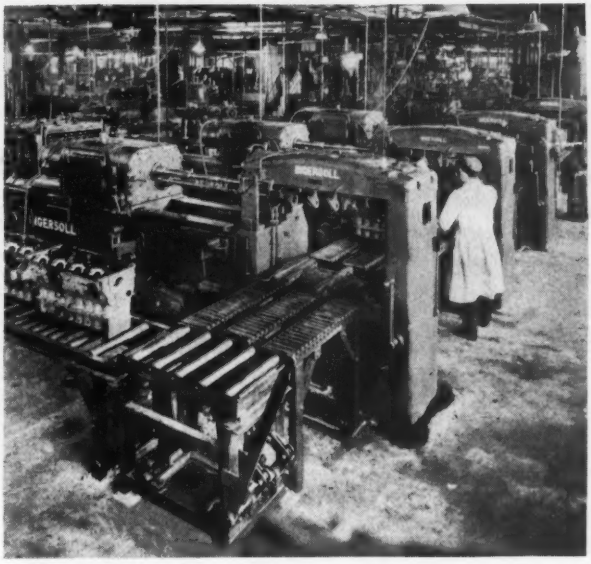
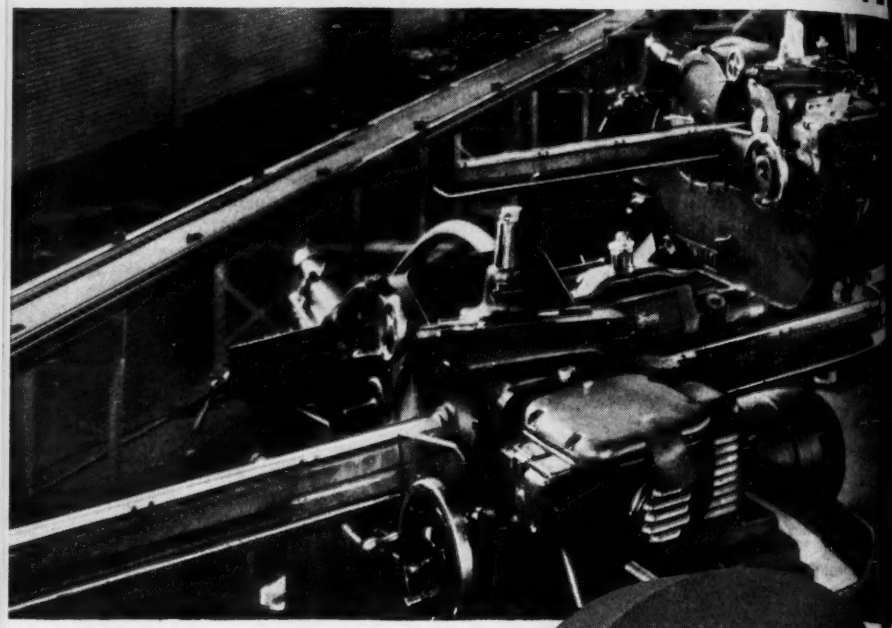
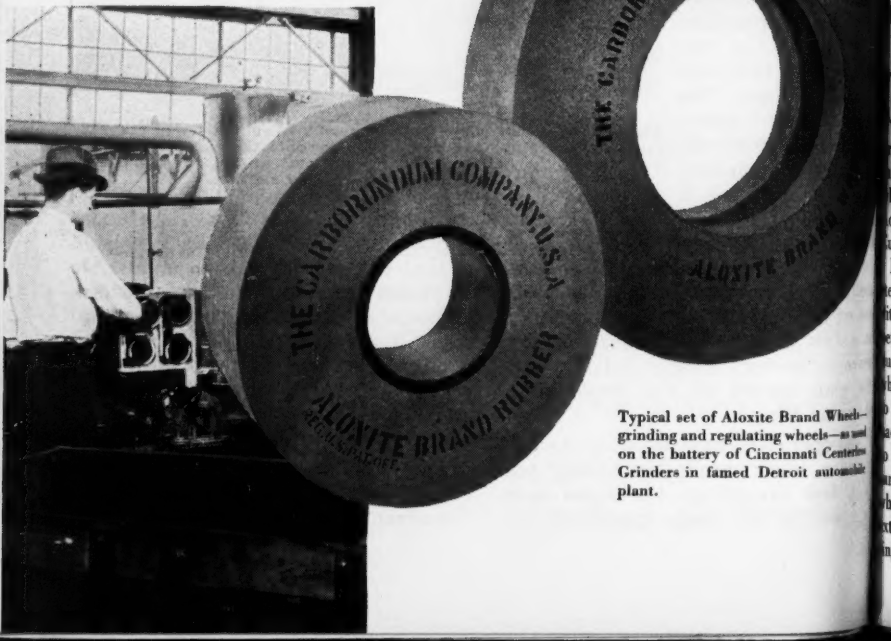


Fig. 2—The blocks come to these machines on the lower conveyor line at the left and are pushed directly onto the elevating section, with which they are elevated to the level of the three conveyor lines extending through the machine.

1934's DRASTIC AUTOMOBIL



Below—Aloxite Brand Mounted Disc Wheels are used in the grinding of ends of the finished springs



Typical set of Aloxite Brand Wheels—grinding and regulating wheels—as used on the battery of Cincinnati Centerless Grinders in famed Detroit automobile plant.

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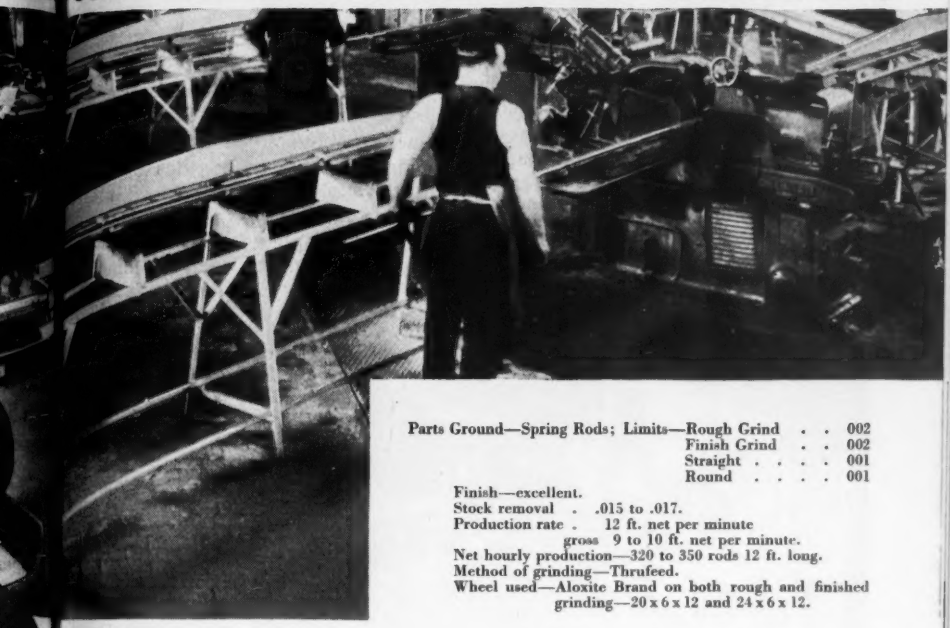

Parts Ground—Spring Rods; Limits—Rough Grind . . 002
Finish Grind . . 002
Straight 001
Round 001

Finish—excellent.
Stock removal . .015 to .017.
Production rate . 12 ft. net per minute
gross 9 to 10 ft. net per minute.
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Method of grinding—Thrufeed.
Wheel used—Aloxite Brand on both rough and finished grinding—20 x 6 x 12 and 24 x 6 x 12.

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Convenient and quick handling is another. Probably the best way to illustrate these facts would be to consider a few typical cases, making a comparison between the conveyors and fixtures now in use and the manner in which the cylinder blocks were handled before the present system was installed.

In the foreground of the illustration, Fig. 2, can be seen a roller conveyor elevating device. The cylinder blocks are received on this unit, elevated from the lower line to three parallel lines at right angles to the lower line, and are then pushed directly onto the machine without manual lifting or handling. A lever on the machine controls mechanism by means of which the blocks are tilted to the proper angle. As will be seen from the photograph, there are several operations at this higher level served by the system of three parallel roller conveyors. What this equipment means in the way of conserving manpower and eliminating fatigue hardly needs stressing.

Figure 3 shows a roller conveyor line arranged to serve several drilling machines. Inasmuch as the blocks for certain models of engines do not go to the two machines shown nearest in the illustration, these machines are set at an angle to the main conveyor line. In front of each machine is a short section of conveyor mounted on a ball-bearing turntable. When a block coming along on the main conveyor line arrives at the turntable section, if it is to be drilled here it is a simple matter to turn the section crosswise and then push the work into the jig on the drilling machine table.

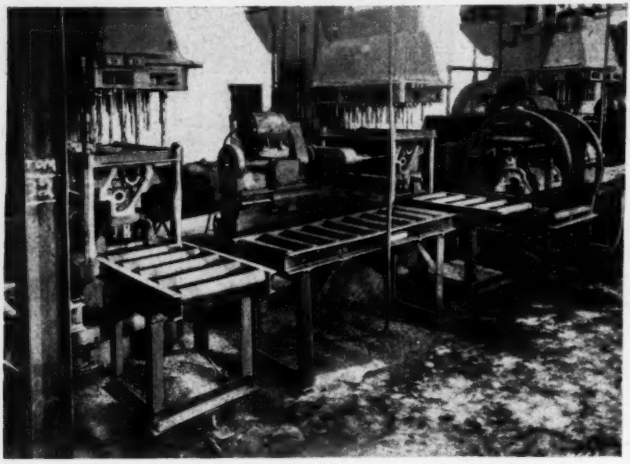

Fig. 3—Conveyor section mounted on a ball-bearing turntable. At the right is a "roll-over" device, for turning blocks upside down without injury to the blocks, the conveyor, or the operator.

On the other hand, if these operations are to be omitted, the turntables are set so that the conveyor line is continuous and the blocks travel on to subsequent operations.

In the right foreground of the illustration, Fig. 3, is a roll-over device by means of which a cylinder block can be turned completely over with no more effort than is required to revolve the cylindrical iron structure. There are points in the series of operations at which the blocks must be reversed so that drilling or other operations can be performed on the reverse sides. Before the "roll-over" devices were installed, an operator had to swing each block crosswise on the conveyor so that it would not fall

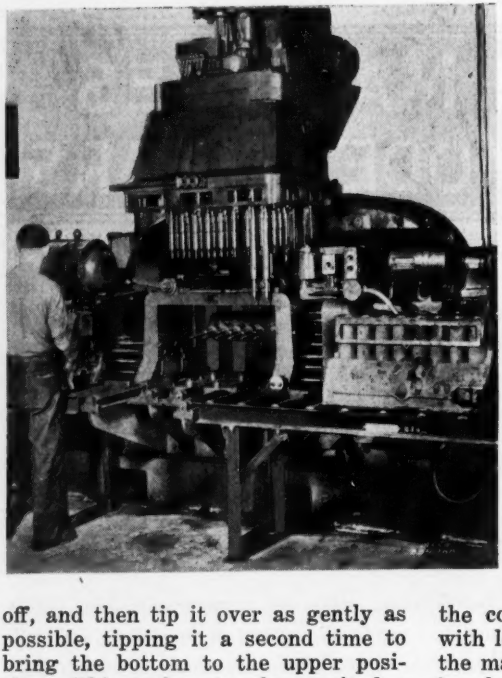

Fig. 4 — The cylinder blocks are moved from the conveyor directly into the fixture on the machine table.

off, and then tip it over as gently as possible, tipping it a second time to bring the bottom to the upper position. This task not only required a considerable amount of exertion, but always involved the risk of injury to the block or to the workman. With present equipment, the block is simply pushed into place in the roll-over device and the device is revolved 180 degrees, then the block is pushed out onto the main line of conveyor again. Guards properly placed in the device, hold the block in position while it is being reversed. The "wheels" of the device roll on rollers which serve as large roller bearings.

Figure 4 illustrates the method of setting the machines so that they can be served directly by the conveyor lines. Here a "four-way" multiple tapping machine is set so that a bracket attached to the front of the machine will form a part of the conveyor. The rollers on the conveyor are of an even height with locating blocks in the fixture on the machine table; thus when a block has been moved into position on the bracket, it is easily shoved into the fixture, where it can be clamped and machined.

At one point in the progress of the

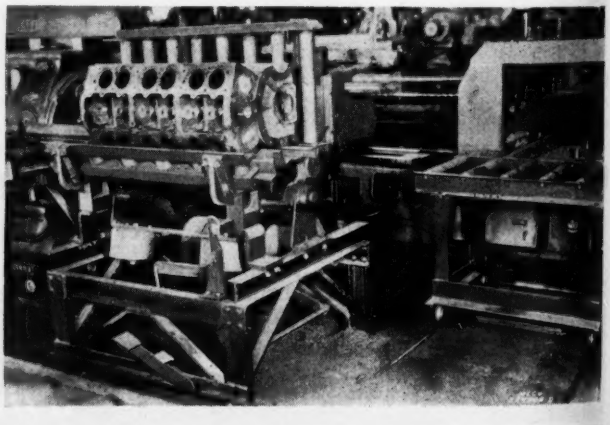

Fig. 5—A "tip-over" device built on trunnions and balanced so that the block may be tipped to any desired angle with a minimum of effort and without injury to the block or the operator. A transfer table, used to move blocks to machines that are out of the line, is shown at the right.

cylinder block through the machining department it becomes necessary to tip the block over onto its side, which must be done as quickly and easily as possible and without damaging the block or conveyor. In order to accomplish this, a section of the conveyor is built on trunnions so that it can be swivelled to the required angle, and a side platform is built on to support the block after it has been tipped over, as shown in Fig. 5. After the block has been tipped, it is moved onto the conveyor transfer car shown at the right in the illustration and is moved to the machine for the next operation. The transfer car runs on a track between machines on either side of the conveyor line, making it possible to move the block to either machine, according to the size of the block.

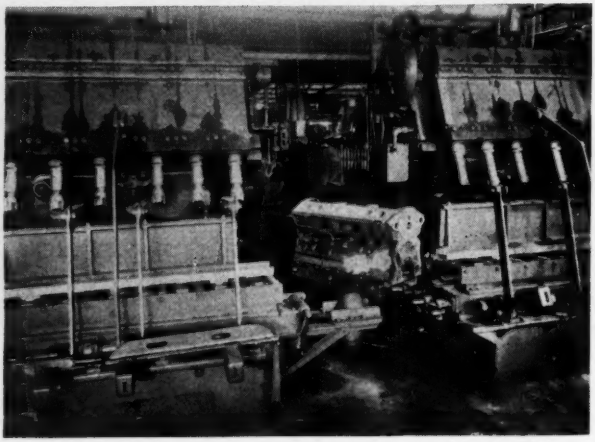

Fig 6—A section of the conveyor built to serve as a turn-table for reversing the position of the block between boring operations.

Figure 6 shows two machines with which the piston holes in the cylinder block are bored—one machine being used to bore the holes in one side of a twelve-cylinder block and the other machine being used to bore the opposite set of holes. This method of machining makes it necessary to turn the block end for end between the two operations.

After the first boring operation has been completed, the block is pushed onto a conveyor section that connects the two machines. This section, however, is supported by a vertical shaft in a substantial bearing, the shaft serving as an axle upon which the conveyor section, with its load, can be revolved. Thus the block can easily be swung about, end for end, and moved into place in the next fixture.

From the foregoing illustration a very fair idea may be obtained as to the efficiency of the ordinary roller conveyor and the possibilities for adapting it for use in the handling of a variety of products. While the principles of this type of conveyor have been illustrated by specific applications in the plant of the Lycoming Manufacturing Company, they are suggestive of what can be done in any machine shop where a sequence of operations must be performed on duplicate pieces of heavy work.

The task of laying out a conveyor line is not a difficult task; to a large extent it consists merely in adapting the standard types of conveyor equipment—with variations such as those described here—to the product and to the local conditions. However, it is a good idea, when contemplating the installation of a conveying system, to consult with representatives of reliable conveyor manufacturers.

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Manager, Industrial Division,
The S. S. White Dental Mfg. Co.

The flexible shaft has won its present important place in machine design because it meets a need which no other mechanical element or combination of elements can meet as simply and as economically. This article explains some of the uses and advantages of the flexible shaft.

THE transmission of power by the use of the flexible shaft is common practice in many lines of manufacturing today, and the applications are many and varied. The uniformly successful performance of all applications establishes beyond question the value of the flexible shaft as a practical and dependable element in machine design.

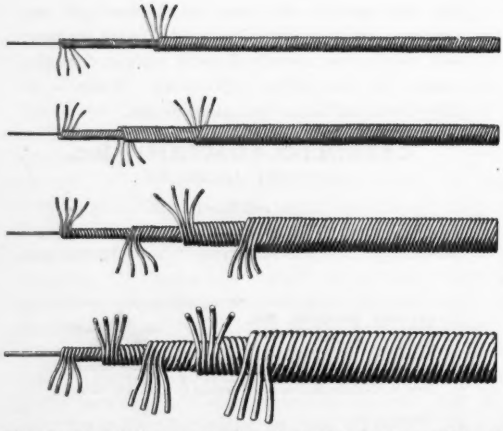

Fig. 1—In winding a flexible shaft, the lead or pitch of the windings alternates and the size of the wire is increased with each layer.

The flexible shaft apparently has two main fields of usefulness. The first is the transmission of power at either high or low speeds with the continuity and properties of a solid shaft, between points so located with respect to each other that a solid shaft cannot be used, such as around corners, at angles, and in other cases where the driving and driven elements are not in alignment. The second is the transmission of motion to elements which must be reciprocated, revolved, or otherwise moved, in cases where the elements to be moved are so located that they cannot readily be reached by hand or where a direct, aligned connection is not practicable.

In other words, the flexible shaft provides a simple and efficient means of transmitting power or motion in many places where uneconomical methods, involving the use of complicated or inefficient mechanisms, would ordinarily have to be used. However, in spite of the fact

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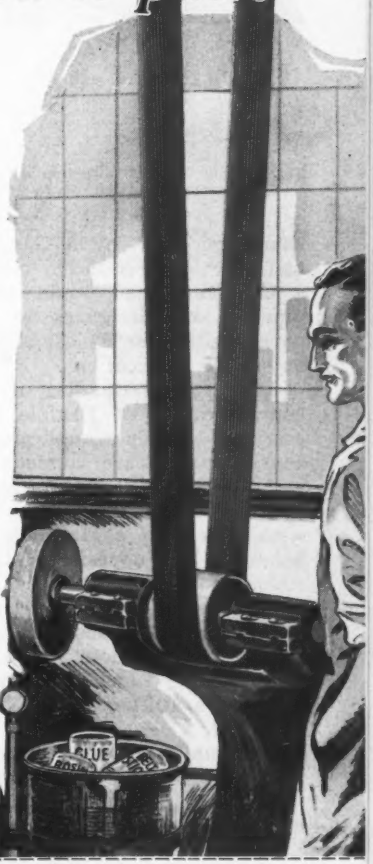

YOU can throw away your sticky belt dressings and forget your belt worries when you equip your drives with VIM TRED—"The Non-Skid Belt." Its live," resilient, treaded surface grips the pulley like a non-skid tire grips the road, and assures you of full speed, trouble-free performance on every drive.

Only VIM TRED offers you these advantages:

DELIVERS MORE POWER AND SPEED to your machines because it has more gripping power than smooth belting.

HUGS THE PULLEY AT ANY SPEED. VIM TRED is so soft and flexible that it grips the pulley firmly at any speed and delivers a smooth, even flow of power.

BLOWS DUST AWAY. As the belt meets the pulley air is forced out of narrow indentations in tiny jets, thus preventing dust from adhering to belt or pulley and causing slippage.

4. RUNS SMOOTHER AND WITHOUT VIBRATION. VIM TRED is pressed to absolutely uniform thickness by the tremendous pressure used in producing the non-skid tread.

5. STRONGEST BELT MADE because it is made of VIM Leather—the toughest, strongest belting material known.

6. LASTS LONGER because it eliminates the two chief causes of belt wear—**SLIPPAGE**, which causes frictional heat, and **DUST**, which grinds away the face of a belt.

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that millions of feet of flexible shafting are now in use in a vast variety of applications, the possibilities of the flexible shaft have hardly begun to be realized. This situation is largely due to two reasons; lack of familiarity with developments that

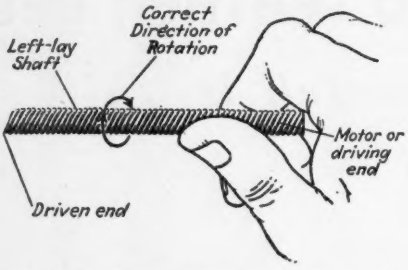


Fig. 2—The correct direction of rotation is opposite to that of the lead.

have been made in the flexible shaft, and lack of information and data of a character that would enable engineers and designers to visualize opportunities for its use and to work out actual applications.

A clear understanding of the basic characteristics of flexible shafts is essential to proper application. These characteristics are commonly designated by the following terms:

Transverse flexibility; the ease with which the shaft lends itself to bending. The opposite of transverse stiffness.

Transverse stiffness; resistance to bending in a transverse direction. Transverse stiffness in a flexible shaft is the same characteristic as transverse stiffness or rigidity in a solid rod.

Torsional stiffness; the resistance to twisting or deflection under load.

Torsional flexibility; the opposite of torsional stiffness.

Internal friction; the friction that may exist between the strands of wire which make up the drive shaft. It is separate and distinct from the external friction between the shaft and the casing when the shaft is deflected. Internal friction varies with the torsional and transverse stiffness of the shaft, the degree of curvature, and the load. Curving a shaft introduces additional internal friction. The consideration of internal friction is of vital importance in shaft construction and is covered more fully in succeeding paragraphs.

Backlash, or initial deflection; the amount of movement or "take-up" of the cable wires from their normal lay to their tightened or driving position. In properly-constructed shafts this slack is so small that it can be measured only with sensitive instruments and is therefore negligible, except in shafts of unusual length or where absolute synchronism between driving and driven elements is essential. In such cases, special shafts can be made to meet the requirements.

Torsional deflection; the angular deflection of the shaft under load. It is generally measured in degrees per

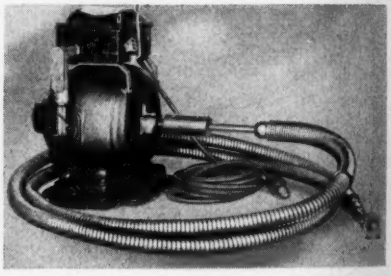
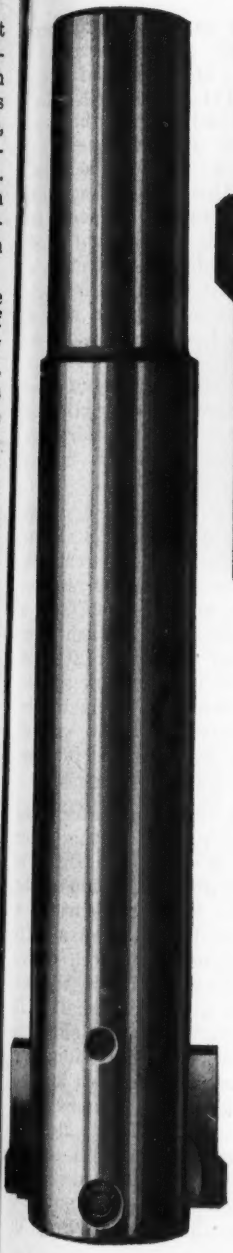


Fig. 3 — Boiler Tube Cleaner. The flexible shaft is regularly employed for this application, as it is suited for severe service, will transmit all the power needed, and operates satisfactorily in long lengths.

unit of length per unit load. It is separate and distinct from backlash, and the amount of backlash in properly-designed shafts is so small that for all practical purposes only torsional deflection need be considered.



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Tendency to set; most flexible shafts which are deflected in fixed curves and remain idle for more or less extended periods tend to take a permanent "set." This tendency is inherently greater in some makes of shafts than in others, but it can be reduced by proper treatment of the shaft in the manufacturing process. In shafts that run continuously the tendency to set is of minor importance since it is obviated by the continual revolving movement.

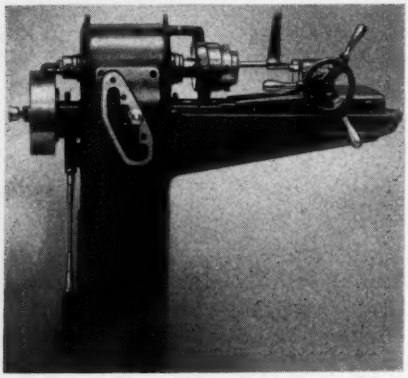


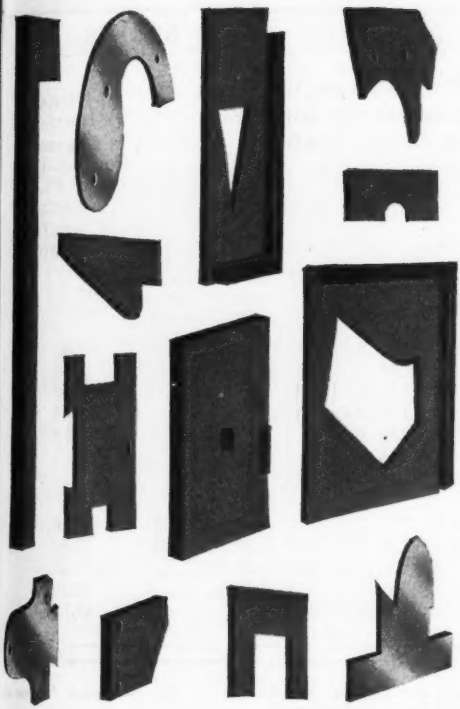
Fig 4—A Machine Tool Application. The two points connected by the flexible shaft are out of alignment with each other, but the flexible shaft bridges the gap in a simple, direct manner.

The ideal flexible shaft for any application is one in which the properties of torsional stiffness, transverse flexibility, and internal friction are carefully balanced. The shaft should be as high in transverse flexibility and torsional stiffness as the conditions of the application will permit, while the internal friction should, of course, be as low as is possible with the combination of the other two characteristics. In other words, the shaft should offer maximum resistance to twisting under load with minimum resistance to bending and at the same time operate with as little internal friction as possible.

There are four basic parts to every complete flexible shaft assembly: (1) drive shaft, (2) drive shaft ends, (3) casing, and (4) casing ends. The most important element of the flexible shaft is, of course, the drive shaft. Assuming proper selection and application, the performance of a flexible shaft in service depends on the quality of this drive shaft, and the quality of the drive shaft depends upon the quality of the material used, the winding process and the method of cutting and fastening the ends. The shaft shown in the illustration is made of a special grade of steel wire of high tensile strength and rigid specifications, and the wires are wound by a process which insures absolute uniformity.

The illustration, Figure 1, shows the construction of the S. S. White flexible shaft, which is generally built up of two or more superimposed layers or wire with or without a single wire in the center. Each layer is usually wound with four strands. As shown in the illustration, the direction of the lead, or pitch, of the windings alternates, and the size of the wire is usually graduated, increasing with each succeeding layer.

The lay of a shaft is determined by the pitch direction of the outer lay of wires. A right-lay shaft is one in which the pitch direction of the outer lay is the same as that of a right-hand screw thread, and a left-lay shaft corresponds in pitch direction to a left-hand screw thread. Figure 2 shows a left-lay shaft. It will be seen that when this shaft is turned in a clockwise direction, the outer winding tends to tighten up and is thus in condition to transmit its maximum capacity. While flexible shafts deliver their maximum capacity when operating in one direction only, they may be used with entirely satisfactory results for driving in



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ESTABLISHED 1832

TABLE OF TORQUE CAPACITIES—DRIVE SHAFTS

Grade of Shaft	Diam. of Shaft (In.)	Safe Torque Capacities in Pounds-Inches for Straight and Curved Shafts								Torsional Deflection in Degrees Per Lb.-In. Per Ft. Length of Shaft (Straight Only)
		Straight	Radius of Curvature							
			20"	15"	10"	8"	7"	6"	5"	4"	
"H"	⅛	4.0	3.2	2.8	2.5	2.2	1.8	1.5	1.1	0.4	40.00
	¼	20.0	16.0	14.0	11.0	8.7	7.1	5.0	2.0	.....	2.30
	⅜	49.0	36.0	31.0	22.0	15.0	10.0	4.0	.....	.....	0.70
	½	78.0	53.0	44.0	27.0	14.0	5.0	.....	.....	.....	0.24
	⅝	112.0	70.0	55.0	28.0	6.5	.....	.....	.....	.....	0.11
	¾	152.0	86.0	60.0	28.0	.....	.....	.....	.....	.....	.....
"S"	⅛	2.3	2.0	1.8	1.7	1.5	1.4	1.2	1.0	0.5	45.00
	¼	11.0	9.0	8.4	7.1	6.1	5.4	4.5	3.2	1.3	2.90
	⅜	26.0	20.0	18.0	14.0	11.0	9.2	6.6	2.5	.....	1.60
	½	50.0	28.0	33.0	25.0	19.0	14.0	8.5	.....	.....	0.30
	⅝	75.0	54.0	47.0	34.0	23.0	16.0	6.3	.....	.....	0.16

(1) Torque figures are approximate and are intended as a basis for selecting a shaft for trial purposes. They apply to shafts up to 25 feet in length and represent the maximum external loads which the shafts will transmit with absolute certainty.

(2) Torque figures are for both right-lay and left-lay shafts rotating in the direction which tends to tighten their outer layer of wires. Rotating in the opposite direction, their respective torque-transmitting capacities are reduced from 20 per cent to 50 per cent. Where regular operation in both directions is required, a size larger shaft should be used than is indicated by the computed torque requirements.

(3) Where no torque figures are given in the table, it indicates that the radius of curvature under which the blank appears is too sharp for the particular size and grade of shaft.

(4) Deflections of straight shafts given in the third column are for new shafts. Continuous operation increases this deflection. Where shafts are intended for continuous operation and this increase in deflection may be of consequence, flexible shaft engineers should be consulted.

both directions. In the latter case, however, the shaft must be of larger size than would be required for driving in one direction only.

Drive shafts are manufactured in long sections which are subsequently cut to length to meet customers' specifications. Before cutting, however, the wires must be secured at the points where the cuts are to be made so as to preserve the tension and prevent the shaft from unwinding. This operation also provides the shaft with practically solid ends which facilitate the attachment of metal terminals or driving connections.

The ends are usually secured either by brazing or swaging. In either case the operation requires special equipment and no little skill, and for this reason it is strongly recom-

mended that shafts be ordered in the actual lengths desired. An attempt to braze or swage and cut the wires without the proper equipment is almost sure to result in a weakened and

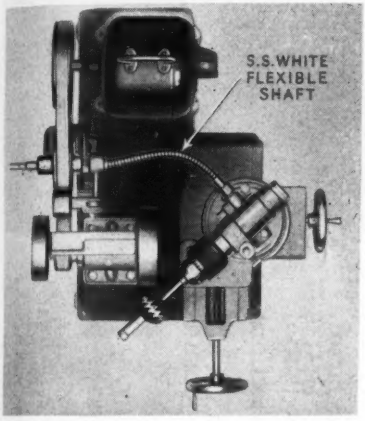

Fig. 5—Transmitting Power at an Angle. Here is a plan view of a valve grinding machine, in which a flexible shaft is used to transmit power to a spindle which, to accommodate the various sizes of work, may be moved in any one of three directions.

less efficient shaft.

In selecting a drive shaft for a given application, the following factors should be taken into consideration: (1) power to be transmitted, (2) speed of rotation, (3) torque on shaft, (4) length of shaft, (5) curve, or curves, if any, (6) direction of rotation, (7) nature of service (continuous or intermittent), and (8) nature of driving or driven elements to which the shaft is to be attached.

The first step is to determine which grade of shaft best meets the requirements of the application. This should be done before selecting the size of shaft required because the same size has a different torque capacity in one grade than in another. In determining which grade of shaft to use, selection should be based on the degree of transverse flexibility most desirable for the particular application.

In selecting the proper size of shaft to use, the torque or twisting force which the shaft must transmit is the principal determining factor. This torque is established by the power to be transmitted and the speed at which the shaft is to operate because power is equal to torque X speed. Torque, therefore, equals power divided by speed. This relationship is expressed in the following formula:

$$\text{H. P.} = \frac{2\ \pi\ \text{TxN}}{33{,}000}$$

$$\text{Transposing: T} = \frac{\text{H.P.x33,000}}{2\ \pi\ \text{xN}}$$

Where T = Torque in pound-feet
N = Rev. per minute
π = 3.1416

Torque in pound-inches equals T in pound-feet x 12.

From this formula it will be seen that for transmitting a given amount of power the higher the speed the

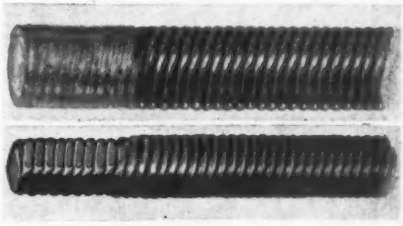

Fig. 6—The brazed end of a flexible shaft is shown above, and below is a swaged end.

less is the torque, the less the torque the smaller the shaft required and the smaller the shaft the lower the cost. There is a distinct advantage to be gained, therefore, by planning to run a shaft at the highest speed possible.

A Message to Machine Tool Operators

Courtesy of HUPP Motor Car Corp.
SPEED: TURNING 9 PINS—1 SET UP—
4 1/2 MINUTES.

THE Machine Tools you operate are modern; set up for proper feeds and speeds; small tools are perfectly ground, yet the machines in many cases *fail to produce at rated capacity.*

Check up on the cutting oil! It is a most important factor.

Numerous machine shut-downs, time lost in frequent tool regrindings, time and material lost in resetting, rejections due to faulty finish and inaccurate tolerances... are a few of many production failures directly traceable to unsuitable cutting lubricants.

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Protect your health. Of special interest is the

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Protect your health. Of special interest is the fact that Sunoco is hygienic. Bacteriological tests prove that it will not permit the development of pus forming bacteria or pathogens which cause skin irritations.

Ask your superintendent for permission to make a test with Sunoco. Learn for yourself the difference there is in the performance of cutting lubricants!

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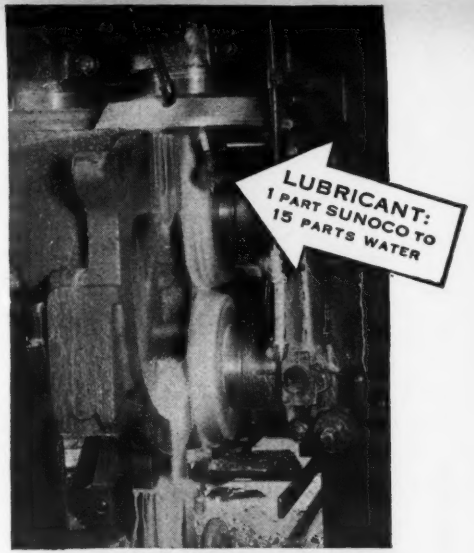

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MACHINE: INGERSOLL MILLING MACHINE.

MATERIAL: .30 CARBON STEEL CASTING.

STOCK REMOVED: 1/16 INCH TO 3/36 INCH.

FEED: .005 INCH.

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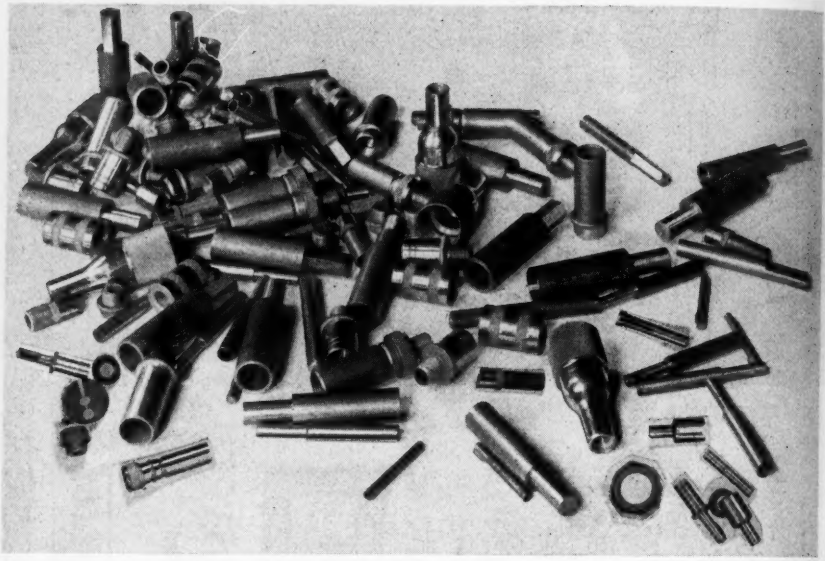


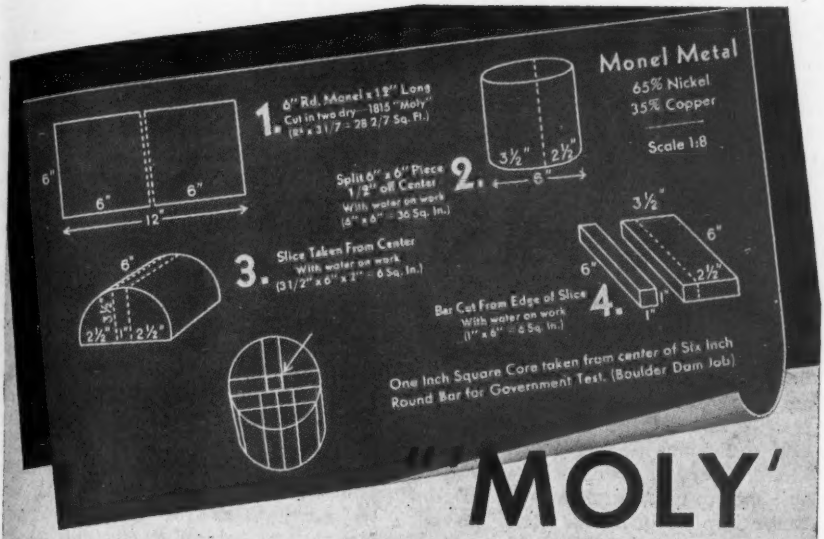
Fig. 7—Group of Drive Shaft End Fittings

Ordinarily, speeds of 1750 to 3600 r. p. m. are recommended as being well suited to flexible shaft operation. However, flexible shafts when properly applied may be run at any speed. In other words, the flexible shaft places no limitations on design from the speed standpoint. For the larger shafts, however, it is generally recommended that their speed should not exceed 500 surface feet per minute.

Flexible shafts are available in practically any required length, but it must be remembered that the longer the shaft, the greater is its own load and the greater is the degree of deflection under load. In very long shafts, also, there is a possibility of an action being set up which may produce an irregular driving moment at the driven end. Shafts up to 50 feet in length have proved entirely satisfactory in special cases, and any length up to 25 feet may be used with assurance of satisfactory performance on ordinary work.

In most cases the drive shaft is equipped with ends by means of which it engages the driving and the driven members. The design of these ends is determined by the conditions of the particular application. A number of such ends are shown in Fig. 7. Some of the ends shown were designed by the manufacturer to meet conditions as specified, and the remainder were made from designs submitted by the prospective users. While it is possible to obtain the shaft plain and apply the driven ends at the point of use, it is good practice to have the ends made and attached by the shaft manufacturer.

In practically all cases the flexible shaft is provided with a casing which acts as a runway or guide for the shaft and protects it from dust or other foreign matter and also from injury. Casings may be made from



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a variety of materials such as braided fabric, metal, leather, rubber-filled materials and so on, but in practically every design of casing, a metal winding forms the foundation over which the other material is laid. Solid tubes are sometimes used as casings where the shaft is fixed, i. e., not intended to be flexed in operation.

The flexible casing should conform as nearly as possible to the drive shaft which it encloses. Thus the ideal combination, the casing and shaft will bend with exactly the same flexure and will parallel each other in the bends. A stiff or heavy shaft in a soft or flexible casing will bear heavily against the casing under certain conditions of curvature and will thus produce undue friction and wear. On the other hand, a soft or extremely pliable shaft loses the advantage of its flexibility if enclosed in a stiff casing. Consequently, combinations such as these should be avoided.

Casings are usually either of plain fabric, reinforced fabric, rubber fabric, or metal. The plain fabric casing is very flexible and comparatively light in weight This casing is generally used on small portable flexible shaft machines designed for light operations where easy flexibility of the shaft is essential and where neat appearance may be a consideration. A metal spring serves as a foundation over which is a series of braidings of cotton yarn. The method of braiding reinforces the casing and greatly strengthens it. This casing is very durable and on applications where it is not brought into contact with rough surfaces will give excellent service.

For applications where the shaft will be flexed continually, the fabric casing can be reinforced with metal at the point or points where the bending occurs. Any size of fabric casing can be supplied with this reinforcement. The rubber fabric casing is exceptionally durable, has little tendency to shrink or stretch, is oil and water tight, and is satisfactory in any length. This casing is comparatively heavy and not as flexible as the plain fabric casing, and for this reason it is not adaptable for very small hand tools where delicate manipulation is a factor.

The metallic casing of the so-called "two-wire" type is particularly adapted for medium-sized tools where the shaft is short and is not flexed to a great extent. This casing resists abrasion and is practically oil tight. The interlocking type of metallic casing is suited particularly for heavier work where extraordinary resistance to abrasion, vibration and the hardest kind of usage are paramount and where very long shafts are required. This casing is strong and stiff and will stand up for long periods under the most severe service.

As a rule, every casing, like every drive shaft, is provided with ends or fittings by means of which it is connected either to a fixed support or to a coupling or hand piece as the case may be.

As in the case of drive shaft ends, the range of possible designs is unlimited. Manufacturers of flexible shafts are able to supply a wide range of standard ends, although special ends can be made to suit any application.

Storekeeping and Ledgers on Gear Jobbing

By M. Zangrilli
Nutall Works, Westinghouse Electric & Manufacturing Co.

STOREKEEPING in gear jobbing shops of today must become modern, along with present day equipment and practices.

The days of looking for a piece of apparatus or material with a flashlight for half a day are gone, along with the practice of Sam Jones, who had to remember that a certain pattern or a finished pinion or gear was located under the steps of the storeroom cellar, after he had nearly scratched all the dandruff out of his hair and racked his brain for 20 minutes.

We must clean up, segregate, and consolidate our materials, have them properly marked and identified in such a manner that if a stranger were to enter your plant he could refer to your storeroom record and walk to the goods for which he is looking.

After this has been accomplished, opportunities will commence to present themselves for cutting costs, shortening delivery dates, and for more efficient production.

The storekeeper of today is holding his company's purse string on storeroom materials. He must be careful that last month's purchases for stock

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*Form 102 W.E.&M.Co. Works Dept.

ORDER NUMBER FT-50686

STOREROOM MAIN DELIVER TO D-5 ON 12-19-33

ISSUED BY DM-VFG DATE ISSUED 12-13-33 CHARGE DEPT. Dep't. D-5

ASSIGNED ITEM	LOCATION	STYLE	MATERIAL	QUANTITY REQUIRED	QUANTITY ISSUED	UNIT COST	VALUE
1-4		640861	L. S. Gear Set	1			

FILLED BY _____ RECEIVED BY _____ DATE _____

Fig. 1—Main Storeroom Requisition, used in withdrawing stock.

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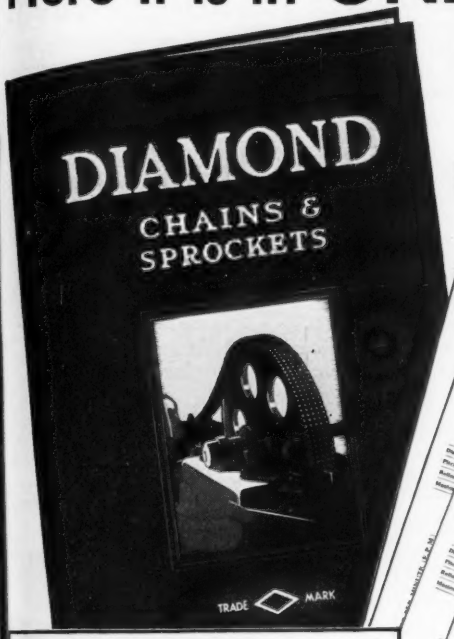

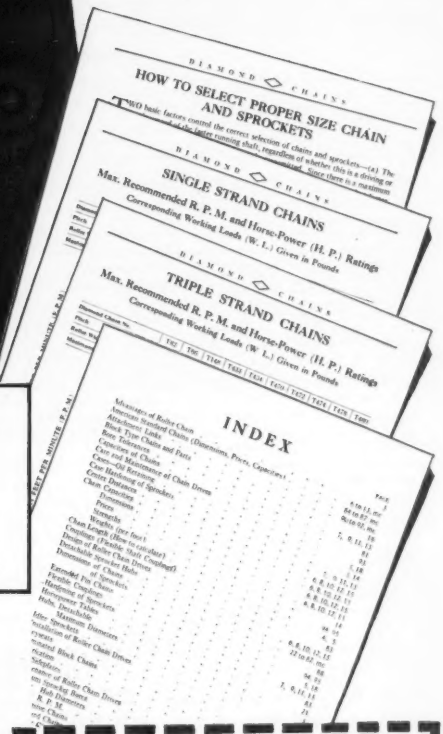

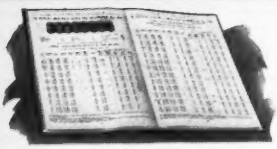

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WESTINGHOUSE FORM 7280 S

_____ ENGINEERING DEPARTMENT

TO THE DRAFTING SECTION ☒ MANUFACTURING INFORMATION SECTION ☒

Please change as follows—

CHANGE DRAWINGS TO HAVE STYLE #638500. CASTINGS
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REASON FOR CHANGE

	CLASS 1	IMPORTANT ENGINEERING CHANGES (ENGINEERING ERRORS)	PERSON RESPONSIBLE FOR ERROR OR CHANGE
	CLASS 2	MINOR ENGINEERING CHANGES—(ENGINEERING ERRORS—NO CHARGE.)	Foreman Dep't. D-5
X	CLASS 3	CHANGES OF A DEVELOPMENT NATURE TO IMPROVE THE APPARATUS, ASSIST FACTORY OPERATION OR REDUCE THE COST	DEPARTMENT RESPONSIBLE
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DOES CHANGE AFFECT DRAWINGS OR INFORMATION SENT TO CUSTOMER YES XXX — IF "YES" FORM 2013 MUST BE SENT TO CLERICAL ENG., BLUE PRINT SECTION AND CARBON COPY ATTACHED HERETO.

IS CHANGE NECESSARY TO MEET CONTRACT? YES XXX NO

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DISPOSITION OF MATERIALS

CASTINGS

PATTERN NO. 1518 MATERIAL OF CASTING C.I.

CASTINGS NEW SUB 5 MAY MAY NOT BE USED FOR OLD SUB _____

IF ANY SCRAP CHARGE EXPENSE TO { FACTORY EXPENSE / S.O. 757

ALL OTHER MATERIALS—IF NO MATERIAL TO DISPOSE OF WRITE WORD "NONE"

None

CHARGES

CHARGE EXPENSE FOR CHANGE IN SHOP TO { FACTORY EXPENSE / S.O. _____

CHARGE EXPENSE FOR CHANGE IN ENG. DEPT TO _____

ENG. _____ DATE _____

TIME FOR CHANGE IN DWG. ROOM ESTIMATED 3 hours ACTUAL _____

ASSEMBLING SECTION D-5 CUSTOMER _____

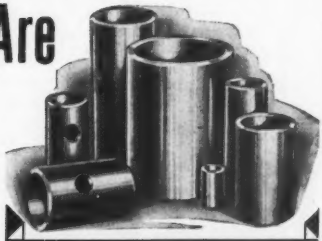
SEND INFORMATION TO SHOP ON

S.O. 14-F 350 READY FOR FILE, SIGNATURE C.C. Conrad (INFORMATION WRITER) DATE 12-12-33

Fig. 2—This form is used whenever changes are made in design or materials.

do not find their way into next month's scrap heap due to obsolescence. In other words, with an engineering department that is constantly

These Bunting Products Are "Right Up Your Alley"



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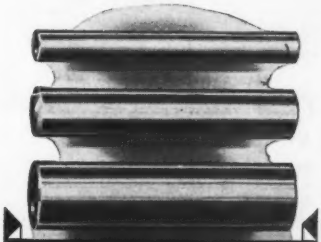
HOW often do you want one or a half dozen bushings or bearings for a job on which time as well as cost is a factor of importance? Then is the time to remember that there are hundreds of Bunting Bushings and Bearings "Ready-Made" completely machined and finished—ready for assembly—ranging in size from ⅜ x ¼ x 1¼ to 4½ x 4 x 7 which you can get instantly in any quantity—a few or a carload. Small lots are sold at the big-run prices. These stock items meet every service need in practically all electrical and machine tool equipment and servicing operations. Ample stocks are constantly carried at all Bunting warehouses. Write for list giving complete specification and price data.



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LEAD BASE BABBITT

The Bunting Brass & Bronze Co.

TOLEDO, OHIO

BRANCHES AND WAREHOUSES:
New York, Brooklyn, Newark, N. J., Boston, Philadelphia, Cleveland, Cincinnati, Detroit, Chicago, Minneapolis, St. Louis, Dallas, Kansas City, Los Angeles, San Francisco, Seattle.

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Bunting's machined and centered bronze bars and Bunting superior lead base babbitt are procurable from leading mill supply wholesalers everywhere. It will pay you to ask for them.

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BUSHINGS · BEARINGS · BARS · PARTS

SUPERIOR LEAD BASE BABBITT

S. S. No.	Date Added to S. S.	Description	Page No. / No.
		Sub Assembly HS Gear Set for FD-20-204	S#-640800

Min. Ava.	Assem. Sec.		Supercedes S. #	Date	Schedule No.
		RATIO 11.2:1			
Size of Order	Location	DWG. 693116	Superceded By S. #		
	29-E-4	Unit Cost 15.55 · Date 10-23-33 · Unit Cost · Date · Unit Cost · Date · Unit Cost · Date	Std. Pkg. Quantity		27-123

Works Schedule: Date	Order No. & Date Prom.	Quan.	G. O. Requirements: Order No.	Quan.	D. O. Stock	Back Order	Date App'd	Balance Available	In Stock Unapplied	Receipts: Date	Order No.	Quan.	Total Received	Issues: Date	Order No.	Quan.	Total	In Stock
Oct.	1933									Oct.	1933							
3	-1	1						1	0	23	-1	1	1					1
									1									
Nov.	1933									Nov.	1933							
22		Cgs	9550	1				0	0					29	9550	1		0
24	-2	1						1	0									

Fig. 3.—Ledger Record of additions to or withdrawals from stock, showing balance on hand.

experimenting and re-designing in an effort to improve the product, unless the storekeeper keeps in close touch with the engineering department so that he knows what is being developed and the chief engineer knows what he is buying, announcements of changes in design may be made while there are yet large stocks of parts on hand that will be rendered obsolete by the changes.

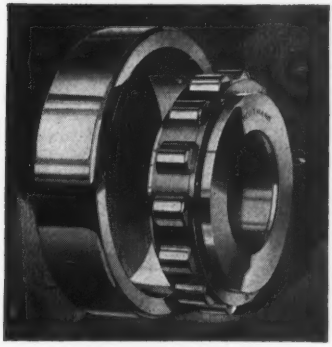
This situation can be controlled by obtaining the authorization of the Engineering and Sales Departments before entering new orders for stock, and arranging for disposition of such stock as will be rendered obsolete by changes in design or in the materials that go into the making of the product. The form used for this purpose is shown in Fig. 2.

In the past, the storekeeper who was caught short on even one occasion by being out of stock was looked upon as being an inefficient storekeeper. If today a storekeeper is never caught short by being out of stock, you will probably learn that he is not investing his company's money wisely.

Controlling of Stock

In order to properly protect the company's investment in stocks of parts, castings, or other materials, the materials should be screened off or enclosed, and unauthorized persons prevented from entering. Any person who wishes to obtain parts or materials from stock should have the proper authorization before the material is delivered, because, after all, the materials being

WHERE NO OTHER TYPE OF BEARING WILL



STAND UP

Because of Extreme Load Conditions, Use

PRECISION ROLLER BEARINGS

With the Heavy Bronze Cage

PARALLEL LINE CONTACT

Solid cylindrical rollers between cylindrical races providing maximum load contact area, increased steady load capacity, and a larger shock-absorbing capacity than any other type of single-row bearing.

SAFETY FACTOR

A margin ample for temporary overloads up to 50% beyond normal rating, as under peak loads, in unusually severe duty, or under shock conditions.

SUPERIOR CAGE

Made of extruded bronze to secure maximum density and uniformity—machined all over for balance—riding on inner ring lands or shoulders, relieving the rolling elements of its weight.

EXTREME ACCURACY

Rollers held to .0001 inch on diameter and to .0002 inch on length, throughout—absolutely true rolling surfaces, ends absolutely square with the sides—highly finished, quiet, friction-free.

DURABILITY

Uniform contact throughout the length of the rollers, providing the most efficient load distribution—greater wear-resisting surfaces—true rolling between all load contact areas—minimum friction between roller and cage.

SPEED QUALITIES

A lower friction coefficient under heavy load than any other type of bearing—a speed ability equal to that of any ball bearing, size for size, up to 35,000 R.P.M.

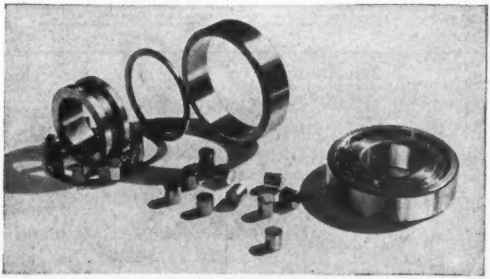
•

There's no duty too hard for a PRECISION Roller Bearing. And, for the less exacting duties, there are PRECISION Ball and Thrust Bearings. Write for the Catalogs—or ask our engineers for suggestions.

Picture to yourself the most difficult load conditions a bearing can be called upon to meet—high speed, heavy load, temporary overloads, shock, vibration. Then read, in the adjoining column, how NORMA-HOFFMANN Precision Roller Bearings—time-tested heavy-duty units—meet these conditions.

• • •

And remember—PRECISION Roller Bearings interchange in size with all standard ball bearings. They can be had—in addition to the standard type here illustrated—in one-lip, two-lip (self-contained), full roller type (without cage), self-aligning and adapter types.



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PRECISION BEARINGS

BALL, ROLLER AND THRUST

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INVENTORY
STORES AND WAREHOUSE STOCK
WESTINGHOUSE FORM 1104 F

ORIGINAL INVENTORY **№ 640405**

STOREROOM OR WAREHOUSE MAIN LEDGER 123

NAME AND KIND OF MATERIAL OR APPARATUS

Sub Assembly H.S. Gear Set

STYLE NO. SIZE OR PATTERN NO.	ARMATURE SERIAL NO.
S-640800	
STOCK ORDER NO.	FIELD SERIAL NO.
GENERAL ORDER NO.	SPECIFICATION NO.
DRAWING NO.	ITEM OR PIECE NO.

		QUANTITY	PRICE	PER	TOTAL VALUE
INVENTORY		0			$
LEDGER RECORD					
INVENTORY ADJUSTMENT	CREDIT LEDGER (RED INK)	FIGURE 4			
	CHARGE LEDGER (BLACK INK)				

COUNTED BY	LISTED BY	PRICED BY
E.W.M.	E.W.M.	
EXTENDED BY	EXTENSION CHECKED BY	LEDGER CHECKED BY

DATE TAKEN 11-30 19 35 LOCATION 29-E-4
TIME ____ A.M. ____ P.M.

NOTE:
STOCKMEN AND LEDGERMEN—ALL RECEIPTS AND ISSUES TO OR FROM THE ABOVE ACCOUNT AS OF THE SAME DATE AS THE INVENTORY SHALL BE HANDLED IN ACCORDANCE WITH THE LOCAL INSTRUCTIONS ISSUED BY THE STOREKEEPER OR STOCK SUPERVISOR AND APPROVED BY WORKS AUDITOR.

Fig. 4.—Inventory Record.

drawn from stock represent a given amount of the company's money. A form for use in withdrawing material is shown in Fig. 1.

Ledgers

After the stocks have been segregated and arranged in orderly fashion in the shop storeroom, it is necessary that accurate records be kept showing the disposition of stock that is withdrawn and the balance of stock of each kind on hand. The stock record men or ledger men should have a minimum ordering quantity in order that the purchasing department may buy in economical quantities and thus obtain advantages in price.

A ledgerman's job, as the writer sees it, is strictly a bookkeeping job. In order for him to keep correct records, he must receive notices of all withdrawals and at the end of each month report ledger balances to the accounting department. Figure 3 is a reproduction of a Ledgerman's Record and Activity Card.

Perpetual inventories should be maintained throughout the year and these figures should periodically be checked in order to make sure that the number of pieces shown on the ledger agrees with the number of pieces in the bins. A difference between the actual number of pieces in a bin and the number shown by the ledger as being on hand is liable to result in a disappointed customer; therefore it is necessary that these records be as nearly perfect as possible. The form used in taking inventory is shown in Fig. 4.

Have you filled in and mailed your card? If you wish to continue receiving this magazine, fill in, tear out, and mail the post card in the front section of this copy. If you know of any mechanical executives with other firms who should be getting MODERN MACHINE SHOP, list their names also. Do this today to insure your name being kept on the mailing list.

By mentioning MODERN MACHINE SHOP when writing to the firms advertising in this magazine, you are helping to build up a bigger and better magazine for your own benefit. Cooperation pays.

Norton Structure Control Assures Proper Cutting Action

IN NORTON WHEELS, proper cutting action and wheel life are insured, not only by grade, but also by structure (the spacing of the abrasive grains). With only grade variations possible, an increase in wheel life is usually made at the expense of cutting rate. But by means of structure changes, wheel life can often be increased without reducing the cutting rate. As an illustration: a 3846-K5B wheel is satisfactory in cutting action, but too short in life. A grade change to 3846-L5B produces a marked increase in life but makes the cutting rate unprofitably slow. A STRUCTURE change to 3846-K6B results in satisfactory life combined with a fast cutting action.

Structure, as a means of fine adjustments in wheel life and cutting rate, may be the answer to those grinding problems where you have tried to reduce grinding costs and have been baffled by having only grade to work with.

Let a Norton engineer study your grinding problems.

NORTON COMPANY
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New York Chicago Detroit Philadelphia
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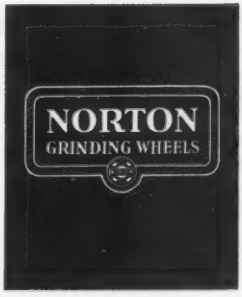

ng Wheels, Pulpstones. Laboratory Ware: Refractories; Porous Plates
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W-474A

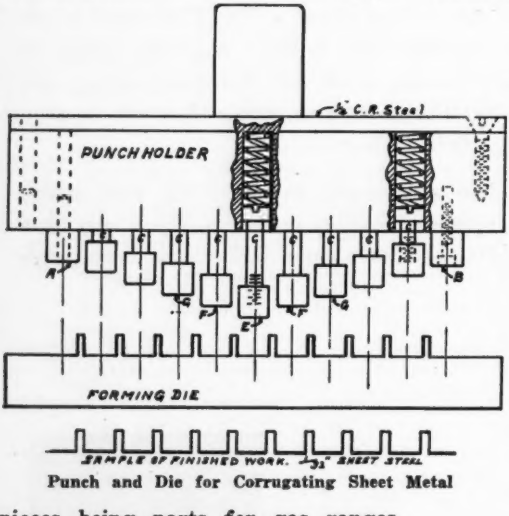
IDEAS FROM READERS

This department is a clearing house for ideas . . . If there is a "kink" or short cut in use in your shop, send in a description of it . . . Each one published will be paid for.

Press Tools for Corrugating Sheet Metal

By Charles Kugler

AN order was received to design and make a tool with which to corrugate sheet metal pieces as shown at the bottom in the illustration, the pieces being parts for gas ranges. The upper part of the drawing shows a cross section of a punch and die that were designed by the writer for this job.



Punch and Die for Corrugating Sheet Metal

The die was made of a shape and size so that a sheet of metal formed over it would be of the exact dimensions required. A series of forming punches was made, as shown, all of which were held in the punch holder. The two end punches A and B were anchored solidly in position with the aid of dowels and screws, and the rest were so built in as to be under constant spring tension. A ¾-in. plate, attached to the punch holder, provided a base for the springs. All the punches except those indicated at A and B were provided with two shouldered screws (C) each, to act as guide posts.

In action, the punch E strikes the work first and forms about half of the first groove before the punches F start operating. About the time punch E completes the first corrugation, punches G start forming, and so on until all the punches are at rest on the bottom of the punch holder.

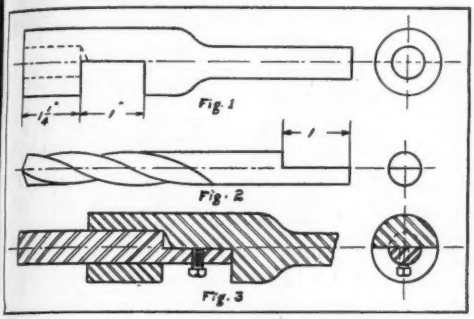
By designing the tools in this manner, the stock is drawn from the outside and thus there is no chance that the work will be torn and spoiled. Only the general design of the tools is shown, details being left to the designer who may wish to adapt this idea.

A Handy Drill Extension

By David Fliegelman

IT frequently happens that a hole must be drilled inside a box-shaped casting or in some similar place where it is impossible to reach with the ordinary drill, held in the usual drill spindle. Or it may be necessary to drill a hole close to the wall of a piece

of work, out of reach of a drill and too close to the wall to admit the spindle of the machine. In such cases the extension shown in the drawing will be found very useful indeed.



A Handy Extension for Straight Shank Drills

The extension is of simple design, consisting of a length of cold rolled steel with a hole in one end and a slot machined crosswise at the bottom of the hole. The hole must be a slip fit for the drill for which it is made, and the slot must intersect the hole at the bottom of the full diameter. The slot must also be cut to the center line of the piece of stock, so that the end of one-half of the hole is fully exposed. The only other requirement for use is that one side of the drill must be ground away for a short distance from the end of the shank, so that it will slip into the exposed half of the hole shown in the drawing.

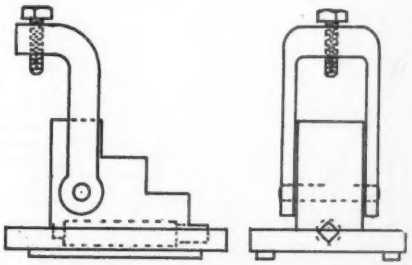
The extension from which the drawing was made was designed for use with a ½-in. drill—straight shank, of course—and was made from a piece of 15/16-in. stock. The hole was drilled and reamed to ½-in. diameter by 1¼-in. deep. Then, starting at the end of the drilled hole, a section 1 in. long was cut away to the center of the shaft, as shown in Fig. 1, leaving the full diameter of the hole exposed in the slot.

One side of the shank of the drill was then ground off at the end, as shown in Fig. 2, for a distance equal to the width of the slot, so that when it was inserted into the extension the drill would mate with the extension as shown in Fig. 3. A setscrew was used to hold them together as shown. The shank of the extension was turned down to a smaller diameter to make it lighter and so that it would fit into a small chuck. This is not often necessary, however; when the diameter is small the extension can be left the full diameter of the stock and used without turning it still smaller.

Hold-Down Fixture for Machining Tires

By D. D. Felter

THE drawing shows the general design of a hold-down fixture which is one of a set of four that are attached to the jaws of a boring mill to aid in holding locomotive tires while they are being machined preparatory to applying to driving wheels. It is impossible to chuck the



Hold-Down Fixture for Boring Mill Chuck Jaw

tires too tightly, as they will be distorted, and if they are not properly anchored, the heavy cuts usually taken in machining such a tire tend to pull it loose.

As shown, the fixture consists of a substantial yoke that is made to straddle the jaw, and is held in place by a heavy pin that serves as a pivot. The yoke is curved so that when in the vertical position the top of the yoke is directly in line with the tire. The tire is locked in position by means of a large bolt through the top of the yoke. The pin that holds the yoke to the chuck-jaw is easily removed so that the yoke may be reversed. It can thus be applied for holding work that is to be turned, the jaw being inside the work.

Boring Locomotive Valve Bushings

By Brent F. Cassell

THE two drawings accompanying this letter, made while I was connected with a Western railway shop, show the method used in that shop for boring valve bushings. The operation was performed on a vertical boring mill, and the job was set up with the aid of the adjustable jacks shown in the drawing.

There were four jacks, each consisting of three pieces as illustrated.

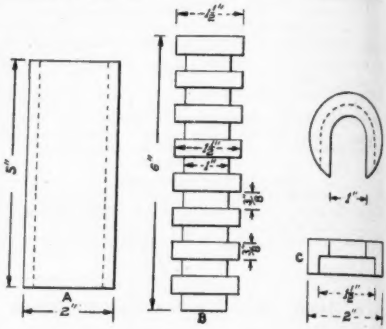


Fig. 2—Drawing Showing Design of Adjustable Jack

The part A is a section of steel tubing through which the adjustable part B is inserted, the part B being supported at the desired height by means of the horseshoe-shaped piece C. The jack can be raised or lowered ¾ in. by moving the piece C from one groove to the next, or a variation of ⅜ in. can be obtained by reversing the piece.

A special set of jaws was used for this job, the jaws having been bored about half way down so that a shoulder was left which supported the bushing at a height which permitted the removal of chips. It also allowed clearance for the tool when it reached the bottom of the cut. The radius of the bore was the same as the radius of the bushings so that a good grip was obtained without too much pressure on the work. A set of jacks similar

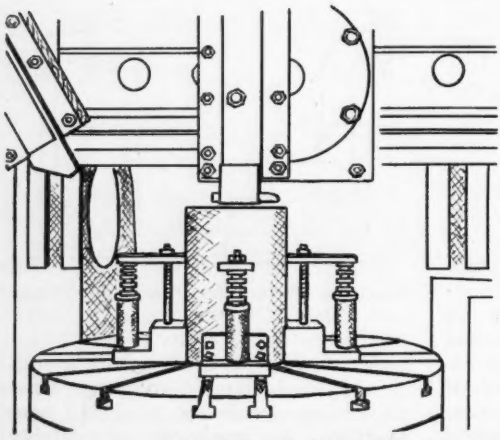


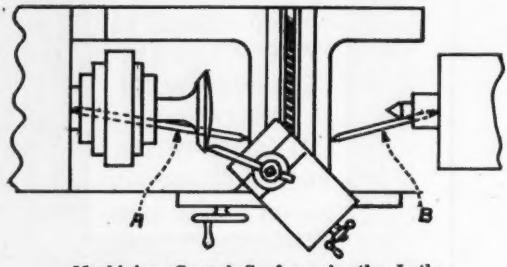
Fig. 1—Locomotive Valve Bushing Set Up for Boring

to the design shown here will be well worth their cost for any boring mill.

Machining Curved Surfaces in the Lathe

By Joe Maslewski

THE drawing illustrates a method of machining curved surfaces in the lathe, this method having been developed in our shop. The method



Machining Curved Surfaces in the Lathe

is extremely simple, requiring no special equipment other than a comparatively short rod. The rod is pointed on the ends to fit into prick punch marks in the carriage and the head and tailstocks, as indicated in the drawing.

For purposes of illustration a plan view of a lathe is shown, with a piece of work resembling a valve head in position in the chuck. Specifications call for a convex face of a length that corresponds to the radius required. The ends of the rod are pointed, as mentioned above, and large prick punch marks are made in the headstock and tailstock exactly in line with the lathe centers and at a height that is even with a corresponding flat surface in the sides of the carriage. Similar punch marks are made in the carriage, as shown.

To machine a convex surface, as shown, one end of the rod is set into the prick punch mark in the headstock of the machine and the other end is set into the mark in the side of the carriage, or cross-slide, as indicated at A. The tool is fed across the work by means of the hand cross feed, constant pressure against the end of the rod being applied by means of the longitudinal feed hand wheel. This is not a difficult matter for an experienced machinist.

For a concave surface the rod is set with one end in the prick punch mark in the side of the carriage and the opposite end in the corresponding mark in the tailstock, as indicated at B.

Over the Editor's Desk

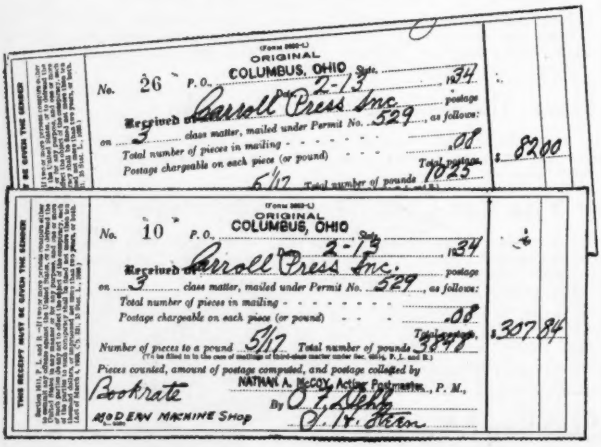
MORE than 28,000 copies of this issue of MODERN MACHINE SHOP are being mailed to as many works managers, superintendents, master mechanics, mechanical engineers, and others who are responsible for production in their respective plants or departments, and each recipient will find in his copy a card which—properly filled and mailed—will tell us that he wishes to have his name continued on our mailing list.

No letter is necessary; simply fill in the information requested and mail. The rest will be taken care of automatically. The important thing is to **DO IT NOW**, and thus avoid missing a single copy. After sufficient time has elapsed for all cards to be in, all names for which no cards have been returned will be removed from the list.

Undoubtedly there are many men holding responsible executive positions in metal working plants to whom this magazine would be interesting and useful, but who for one reason or another have been overlooked. When mailing your card, you can perform a service for them and for us by filling in the names of such men in the spaces reserved for this information on the reverse side of the card. We will appreciate your cooperation.

Undoubtedly our readers will be interested to know that, as we go to press, 34 new firms—concerns who have not been represented in these columns before — are presenting the stories of their tools and equipment in the advertising pages of this issue. This makes 79 new advertisers this year—and the year is young. May we be allowed to suggest that a study of the advertising pages, each month, will go a long way toward keeping the reader posted as to the newest and best in methods and equipment.

Incidentally, we are always glad to serve our readers to the best of our ability by furnishing any information requested. And we are just as glad to have suggestions for the betterment of the magazine.



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5 1/17 Total number of pounds 1025

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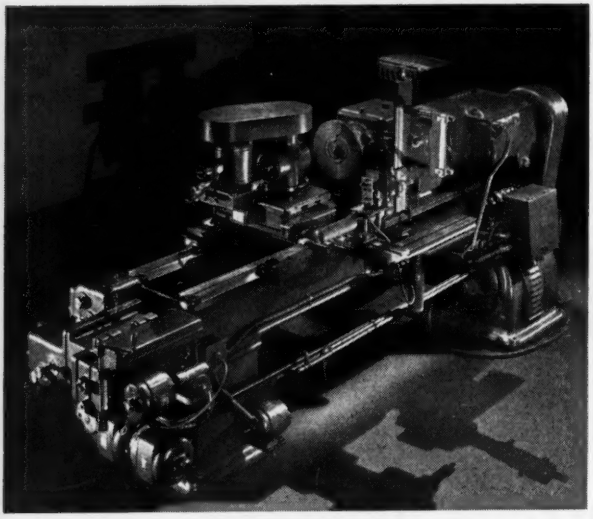
NEW SHOP EQUIPMENT

Monarch Cam Milling Attachment

The Monarch Machine Tool Company, Sidney, Ohio, has announced the development of a cam milling attachment which, when used in combination with the Monarch-Keller Lathe, Centrode Device, and Oval Chuck, comprises a universal machine tool that is capable of efficiently and accurately performing a wide variety of machining operations. The Monarch Cam Milling attachment consists of a sub-headstock that bolts on the bed of the lathe directly in front of the regular headstock. It is driven by a silent chain from a sprocket bolted to the flanged spindle nose of the regular headstock. A complete universal milling fixture fits readily on the carriage of the lathe, in place of the regular compound rest.



Monarch-Keller Automatic Cam Milling Attachment applied to a 20x48-in. Monarch-Keller controlled lathe.

This attachment can be applied only to the Monarch-Keller controlled lathe. It is especially adapted to milling face cams, single or double track cams, barrel cams and other irregular contour work from a master template. The milling headstock has a worm drive spindle giving a 450-to-1 reduction from the spindle speeds provided in the main headstock of the lathe. The flanged spindle nose, on the milling headstock, is identically the same as the flanged spindle nose on the headstock proper, so that all chucks, plates and fixtures will readily interchange. Only a few minutes are required to place the cam milling attachment on the Monarch-Keller lathe and make it ready for production.

The milling spindle, mounted on the carriage of the lathe, swivels at any angle. It is mounted on precision Timken tapered roller bearings operating in oil. The milling spindle has a No. 9 B & S taper to handle the various classes of end mills which may be required for the various milling operations. The drive to the milling spindle is from a 1 h.p. A.C. motor. This motor is mounted vertically on a movable bracket, on the carriage, in order to keep the Vee drive belt from the motor to the milling spindle in proper tension. Three-groove Vee belt pulleys are provided, and may readily be interchanged between the motor and the milling spindle, thereby giving six milling spindle speeds as follows: 200, 315, 485, 700, 1090, and 1700 r.p.m.

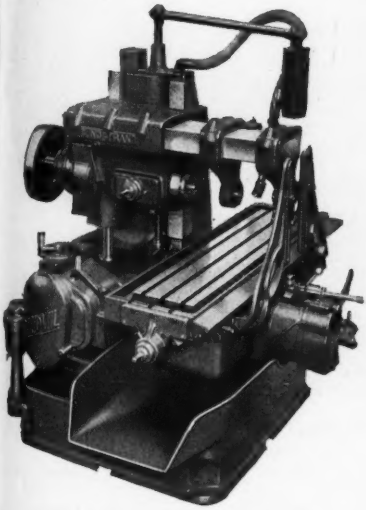
Templates for the cam milling machines are always made in 12 in. length, the templates being made of approximately 1/16 in. zinc or other soft metal. These templates are laid out in a flat plane, and the template travels its length, or 12 in. to one revolution of the work, completing the 360 degrees in

the circle. When the work has made one complete revolution, a precision contractor switch disconnects the current to the magnet clutch. The clutch drives the milling headstock spindle, thereby stopping the machine automatically.

Face cams, 23 in. in diameter, and barrel cams 21 in. in diameter may be produced on this machine. Actual swing over the bed of the milling headstock is 28½ in.

Sundstrand No. 3-A Rigidmil

Since the No. 3 Rigidmil was brought out by the Sundstrand Machine Tool Co., Rockford, Ill., a number of improvements have been developed and these improvements have finally become so numerous and so important that it has been decided to incorporate all of them in a completely-redesigned machine to be known as the No. 3-A Rigidmil.



Sundstrand No. 3-A Rigidmil

Simpler than the No. 3 machine in some respects, with a still broader field of application, the No. 3-A machine may be obtained with low-speed, medium-speed, or high-speed heads, with either vertical or horizonal spindles, and with reciprocating or rotary table. The electrical control is centralized in a pendant which may be swung freely to any position.

The heavy sleeve on the No. 3-A ma-

chine allows the application of power closer to the spindle-nose than is possible with the No. 3 machine. The quill adjustment has been increased and is now more positive and more rigid. A reciprocating table in either of two lengths can be used, or a rotary table in either of two sizes with continuous feed or automatic alternating feed and rapid traverse. The base, column, and saddle are all one casting, providing an increase in strength and rigidity.

A new housing has been developed for the spindle speed pick-off gears, providing an improved mounting for better operation and easier changing. Spindle speeds available through pick-off gears range from 25 r.p.m. to 1150 r.p.m.

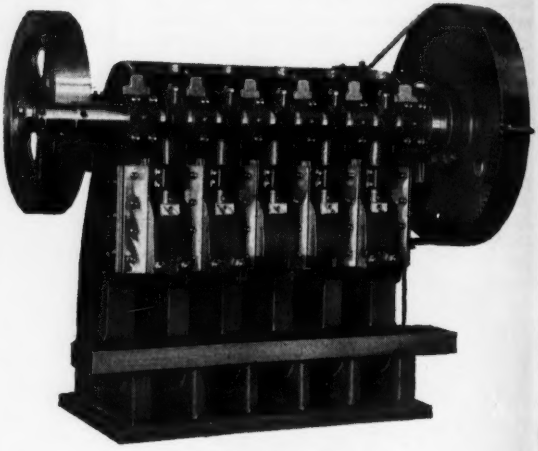
The heavy spindle, which is mounted in four taper roller bearings, is well supported. New arbor support braces are designed with integral tenons, and can be swung aside quickly without removing from the machine. The control of the table cycles is simple and centralized. Rapid traverse speed is 250 in. per min. and protection is provided against shocks.

Table feeds of 4.63 in. to 51.40 in. per min. are available through the use of six pick-off gears. Gears for a low series of feeds, in seven steps from 1.64 in. to 4.14 in. per min. are available as extras. A quick-change feed gear box is also available, as shown in the illustration. Mounted in place of the pick-off gear housing, the gear box provides 12 table feeds ranging from 0.74 in. to 29.00 in. per min., selected directly by the operation of one lever and a slide at the top of the box . All feeds are shown on a direct reading dial.

Table lengths of 50 in. and 62 in. are available, with power feed lengths of 24 in. and 36 in. The table width is 14½ in. Vertical adjustment of spindle on the standard column, 10¼ in.; on the extended column, 14¼ in. Length of saddle, 36 in. Floor space required for standard machine, 67 x 97 in.; for wide throat machine, 72 x 97 in. Base dimensions, 42 x 40 in. Weight, pick-off gear type with motor, standard throat, 5550 lb.; wide throat, 5750 lb. Quick-change type with motor, wide throat, 6080 pounds.

Rockford Five-Slide Press

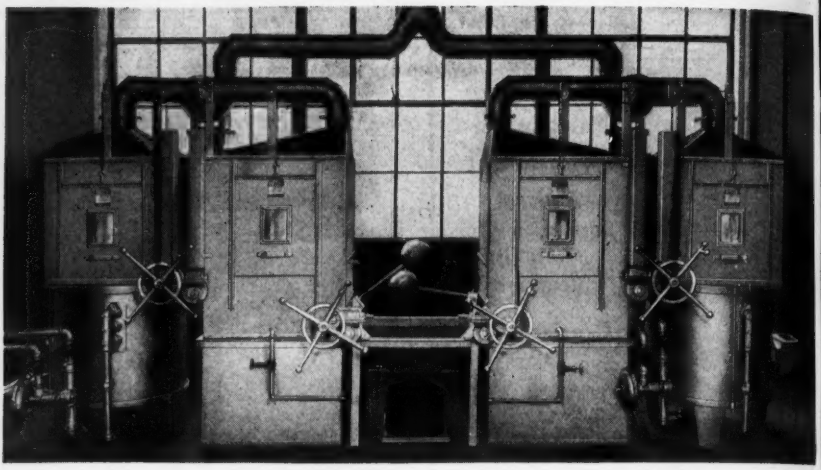
Presses with two, three, four, or five slides are now being built by the Rockford Iron Works, Rockford, Ill. On small parts where the time consumed in handling the work is an important factor, the piece can be moved from one die to another on the same press, thus eliminating the necessity for transportation between operations. Considerable set-up time can also be saved by the use of the multiple-slide press, as in many cases it relieves the necessity for changing set-ups. Where the efficiency of four or five machines is available in one, the tools can be left set up for longer periods.



Rockford Five-Slide Press

The machine shown in the illustration is a five-slide press, the five slides operating from a single crankshaft. Each slide is an independent unit, having its own adjustment. The bearings throughout are bronze-bushed, the crankshaft is of heat treated steel, and the frame is a semi-steel casting. Three of the slides were designed for the conventional type of punch holder, while two were made shorter for special work.

This press is made with any number up to five, and in either flywheel or geared type. The unit shown was designed to be placed on a special base. The connections, screws, rams, flywheels, and clutch are all standard parts of the Rockford No. 1 and No. 2 Inclinable Presses.



Hyro Automatic Furnace. Illustration shows right and left hand units combined for one-man operation.

Hyro Automatic Heat Treating Furnace

The Hyro Automatic Furnace, which is said to make possible the heat treatment of steels with cyanide or other salts, lead, or oil and by a simple, uniform, and economical process is now being offered to industry by the Parker-Kalon Corporation, 200 Varick St., New York, N. Y. The furnace was originally designed and built by experienced steel treaters for their own use, but created so much interest that it was placed on the market.

The furnace can be fired with either oil or gas, and the complete outfit of equipment required for the operation is combined and completely enclosed. The work travels from the loading end to the discharge hopper completely protected from outside drafts by casings. The exhaust gases from the furnace are utilized to pre-heat or dry the work while it is in the loader, and fumes are thoroughly exhausted by means of a motor-driven blower which is an integral part of the unit. A series of feed jets and outlets in the quench tank provide for maintaining the quenching fluid at an even temperature.

The furnace can be constructed to economically handle practically any kind or shape of work that is produced on a production basis, and one man can operate as many as four Hyro furnaces, depending upon the cycle of operation. It can be used equally well for heat treat-

ing small parts in a basket or parts of sizes and shapes that can better be handled on racks.

When racks are used the carrier arms convey the work from the preheater unit to the furnace and thence to the quench tank perpendicularly, permitting uniform heat treating and a vertical quench, thus avoiding distortion of the work.

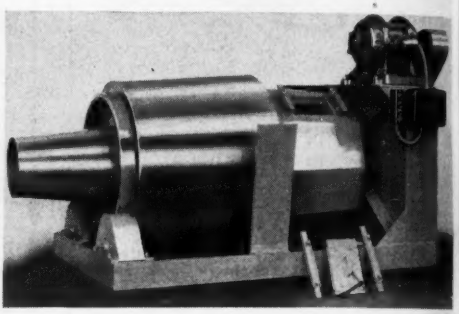
Every part of the furnace is constructed to give long service. Parts which must receive attention periodically are made quickly accessible. Sliding doors in the casing allow easy access to all parts of the furnace, and all casing windows are equipped with Pyrex glass, which is not affected by hot solutions.

Standard equipment for each Hyro Automatic Furnace includes a stock-size pot, basket, bailing ladle, and loading scoop, also eyebolts and bar for lifting the pot out of the furnace. Standard units do not include the loader. Furnaces can be supplied without blowers where other ventilating apparatus is available.

Ideal Ball-Return Side-loading Burnishing Barrel

A new departure in burnishing equipment which results in a saving in time and labor, a better finish of the work, and a definite and substantial reduction in burnishing costs, has been developed by N. Ransohoff, Inc., Carthage Station, Cincinnati, Ohio.

The saving in time and labor is accomplished by a unique method of unloading the barrel, automatic separation of the balls from the work, and automatic return of the balls to the burnishing compartment. The work is loaded into the Ideal barrel through a door in the periphery somewhat as in the case of the standard barrel where the diameter is greater than the length. A cylindrical screen is attached to the end of the burnishing section and connected to it by a suitable passage of patented design. This screen is surrounded by a cone for retaining the balls after separation from the work and this cone is connected to the burnishing compartment by a patented passage of special design.



"Ideal" Ball-Return Side-Loading Burnishing Barrel

After the burnishing has been completed, reversing the direction of rotation discharges the work and the balls into the screen. Here the balls are separated from the work, the former falling through the perforations in the screen into the surrounding cone and the latter passing out from the end of the screen. The barrel is then stopped and loaded with another batch of work. Running again in the burnishing direction automatically returns the balls from the cone to the burnishing section; thus the time formerly required to separate the balls from the work is saved, also the time that would otherwise be required to empty and reload the barrel.

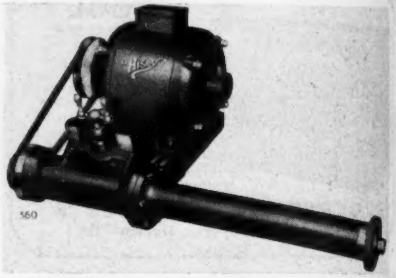
In addition to this great saving, a greater quantity of balls can be used than is economical in the old type barrel. This results in a faster and better burnishing action.

The advantage of the end discharge is that it permits of greater diameter in the burnishing compartment without excessive loading height. This greater diameter and the use of more balls produce increased burnishing pressure, resulting in better and faster operation.

The drum is ten-sided, and the sides and ends are lined with maple. Balance is obtained by three-point suspension, with one long flat bearing at the loading end and two chilled steel rollers running in roller bearings at the discharge end. Power is supplied by a 720 r.p.m. motor through a V-belt drive and cut gears. The machine is built in several sizes and with a wide range of screen perforations to accommodate various types and sizes of work.

"Hisey" Internal Precision Grinder

An internal grinding attachment that is designed for a wide range of accurate internal grinding and is readily adaptable for use with the lathe or boring mill is now being offered by The Hisey-Wolf Machine Co., Cincinnati, Ohio. The



"Hisey" Internal Precision Grinder

grinder is not only indispensable for tool and job work, but is constructed to perform satisfactorily in continuous duty, as for production work.

The grinder is so designed that internal grinding can be done up to the full swing of the machine upon which it is mounted. The grinding spindle, together with the motor, can be swung end for end so that grinding can be done either to the right, as shown in the illustration, or to the left of the machine. The direction of rotation of

the wheel is reversible through the motor. Matched precision pre-loaded ball bearings are used on the grinding spindle, and the motor is also ball-bearing equipped. The motor is balanced dynamically, and is rated for continuous duty with temperature rise not to exceed 40 deg. C.

Spindle speeds furnished as standard are as recommended by the Grinding Wheel Manufacturers. Extra pulleys are supplied to provide practically any desired speed. The dovetail slide with screw feed and handle affords rapid adjustment of the wheel to the center of the work. This adjustment does not affect the belt tension, due to the angle of the slide.

The grinder is made in four sizes; ½, 1, 2 and 3 h.p., and each size is equipped with a powerful constant speed motor which will maintain its speed under any load within its rated capacity. Not depending upon speed for power, special bonded wheels are unnecessary and ordinary vitrified wheels can be used with safety. The machined motor slide base affords rapid belt adjustment.

The V-belt drive transmits more than 99 per cent of the motor output without slippage. This type of drive requires very little tension, adding to the life of the belt and bearings. The grinder can be used in any position from horizontal to vertical. Combination labyrinth and contact seals preclude the possibility of dust getting into the bearing chambers. All oil that is put into the machine is automatically filtered.

Landis Collapsible Taps

The Landis Machine Co., Waynesboro, Pa., has announced a line of collapsible taps to supersede the Victor Collapsible Taps formerly manufactured by the Victor Plant of this company.

The new taps are made in two types; the Landis Style LT, a collapsible tap for either straight or taper tapping, and the Landis Style LM Receding Chaser Collapsible Tap for taper tapping. The taps can be used either as stationary or rotary taps.

The outstanding feature of the new Landis Taps is a design, on which patents have been granted, whereby the tap consists of two units; a tap body containing the operating mechanisms, and a tap head in which the chasers are supported. This design obviously offers many advantages since it permits the use of one tap body to cover a wide

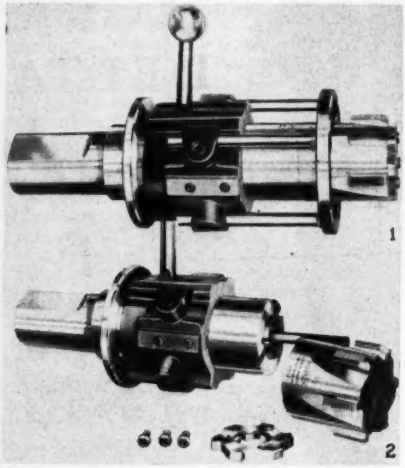


Fig. 1—Landis Style LT Collapsible Tap, for either straight or taper tapping. Fig. 2—Landis Style LT tap with the detachable head removed from the tap body.

diametrical range by the application of tap heads of various sizes. In addition, the same tap body may be used for either right or left hand tapping, providing right and left hand tap heads are employed.

The collapsing mechanism of the Landis Taps is positive in its action both with respect to locking the chasers in cutting position and in its collapsing action. The collapsing action is obtained through a hardened steel trip ring coming in contact with the part being tapped, thus insuring uniform thread length. The trip ring is adjustable for various thread lengths.

The tap heads are adjustable for size through an adjusting screw located in the form end of the plunger. The screw is self-locking and is of the ratchet type so that a turn of the screw of one notch gives an adjustment to the chasers amounting to exactly .001 in.

The chasers are supported in slots in the tap head and are held securely in tapered seats in a hardened and ground plunger. The design of the plunger is such as to provide maximum rigidity for the chasers and at the same time there is no tendency for the plunger to rotate under cutting strains and thereby force the chasers out of alignment. All locating surfaces of the chasers, as well as the thread form itself, are precision ground.

The Landis Style LT Collapsible Tap is designed primarily for straight tapping, but can be used very successfully for tapping tapered threads of a length not exceeding the American Tapered Pipe Standards. The Style LT Taps are

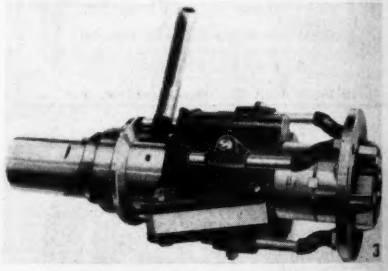


Fig. 3—Landis Style LM Receding Chaser Collapsible Tap.

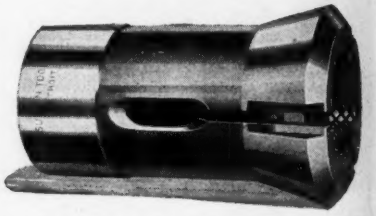
made in five sizes which, when equipped with the proper tap heads, cover a combined range from 1¼ in. to 13¼ in. inclusive.

The LANDIS Style LM Receding Chaser Collapsible Tap is designed for tapping tapered threads. The receding chaser action minimizes cutting strains on this class of work with the result that greater accuracy and longer chaser life is obtained. The Style LM Taps are also made in five sizes covering a combined range from 1¼ in. to 12 in. or 1½ in. to 13⅜ in. diameter.

Sutton Compensating Master Collet

A new design of master collet with interchangeable and replaceable pads for automatic and hand screw machines is offered by Sutton Tool Company, 2842 W. Grand Blvd., Detroit, Mich. These collets are marketed under the tradename of Sutton Compensating Collets, Style "G".

The pads of the collet are self-adjusting within the master. An angular seat in the master and a radius on the back of the pad provide a two-line contact between pads and master, allowing pads to rock in two directions to a perfect bearing on the stock. This feature enables the collet to adjust itself to the surface inequalities of hot-rolled stock without decrease of gripping power. Pins in the master engage blind holes in the pads to prevent the pads from rotating. A flat spring holds the pads

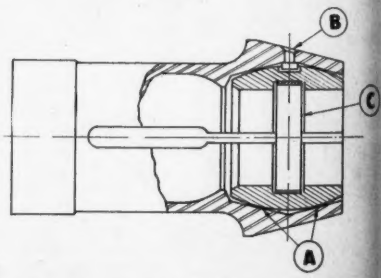


Sutton Compensating Master Collet

securely against the master. The recess in the pads that receives the spring is deep enough to keep the spring out of contact with the work.

The pads have diamond serrations instead of the conventional rectangular serrations. It is claimed that diamond serrations develop superior gripping power under reduced tension and greatly lower the chance of spoiled work due to slippage.

One Sutton Style "G" Master and different sets of pads will handle practically the full range of one machine.



A. Angular seat in master and radius on back of pad provide two-line contact between pads and master, allowing pads to adjust themselves by rocking in two directions to perfect bearing on stock. B. Pins in master engage blind holes in pads to prevent pads rotating. C. Flat spring holds pads securely against master. Recess in pads is deep enough to keep spring out of contact with work.

Pads are interchangeable on different makes of machines of the same machine size. Each different make of machine requires its own master, but the pads are interchangeable from one master to another.

Blanchard Pulsolator

An automatic oil lubrication system for industrial machinery by which fresh oil is constantly fed to bearings while the journals are in motion, thus maintaining a film of oil about each journal or shaft bearing, is now being supplied to industry by the Lubrication Division of the Rivett Lathe and Grinder Corporation, Brighton, Boston, Mass.

This equipment, known as the Blanchard Pulsolator, consists primarily of a pumping unit that can be driven either direct from the machine to which it is attached, or by an auxiliary motor wired to the controller. From the pumping unit radiates a main loop oil line with as many auxiliary or drip lines as there are bearings to be oiled. These lines

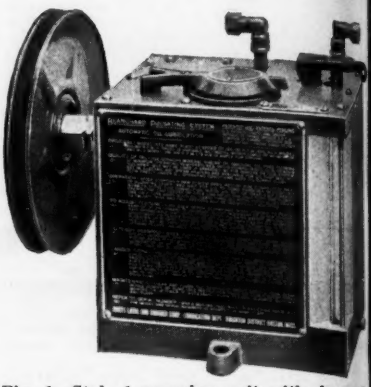
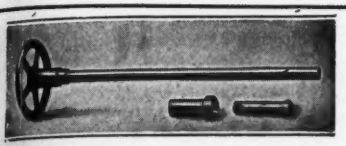


Fig. 1—Style 1 pumping unit with sheave for V-belt drive.

through which the oil is conducted to the individual bearings, are of copper tubing. The drip lines are connected to the main line through feeders which are individually adjustable so that the correct amount of oil can be supplied to each bearing.

The feeding of oil is visible at all times through sight glasses, and any feeder may be adjusted to a rate as slow as one drop in ten pulsations or as fast as five drops to one pulsation. As the number of pulsations per minute or per hour is governed by the model of pump selected and the speed at which it is driven, individual feeds as low as a drop an hour or as high as thirty drops a minute can be obtained.

Up to a hundred feeders can be operated from one pump, and these can be arranged in gangs with drip lines to



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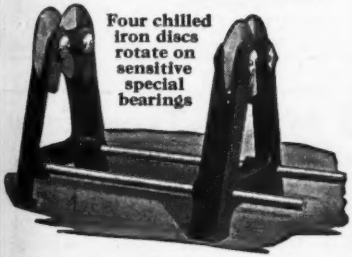
96 in.	88 in.	10,000



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groups of bearings or directly located at bearing points with the loop line leading through them, or on dead end or branch pipe lines.

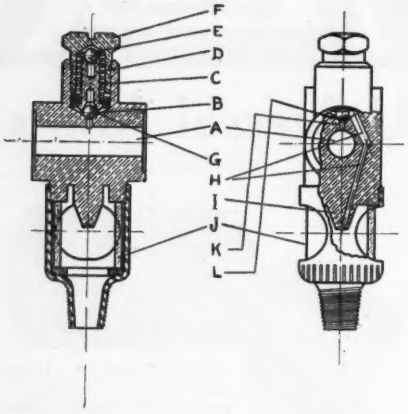

Fig. 2—Cross section of a gang type of feeder.

The indicating lever rises and falls at each pulsation, twice a minute, or more or less often in systems for feeding more or less oil. It also serves to flush all bearings. When held down for a few seconds, as when starting a cold machine, it causes all feeders to drip oil rapidly. When the lever is released, the feeders resume their adjusted operating rates.

The system as a whole is enclosed, except when filling the reservoir. As filler and intake screens are always in place, no dirt can enter. The pump is self-lubricated and will run for years without perceptible wear. It is a double unit of the plain plunger type with piston valves, positive in action. A valve plate driven through worm and gear reduction periodically covers the oil return port and subjects the column of oil in the loop line to greatly increased pressure as determined by the loading of the pressure relief valve springs. Thus when the return port is opened, which occurs when the cycle is about 90 per cent completed, the oil circulates under low pressure and when the return port is closed, pulsation pressure is developed. Instants of pulsation pressure therefore occur, of brief duration.

The pressure curve is that of a straight line with regularly spaced saw-tooth peaks. The feeder valves are affected

only by the pulsation pressure and entirely resist the circulation pressure so that feeding of oil is only at the peaks of the intermittent pulsations. The arrangement is especially interesting since it permits of measurable amounts of oil being fed, whereas in constant feed systems the flow through feeders, except where large quantities of oil are required, is practically imperceptible.

Figure 2 is a cross section drawing of the feeder. A continuous column of oil is pumped through passage **A** at a minimum circulation pressure. At every instant of pulsation the increased pressure forces the ball **B** upward, overcoming the resistance of the spring **C** and lifting the spindle **D** with the upper ball **E** until the latter contacts with adjusting screw **F**. The adjustment of the screw **F** determines the clearance of ball **B** from its seat **L**, thus measuring the quantity of oil trapped in chamber **G** at each pulsation. Immediately on cessation of the pulsation pressure, the spring **C** acts to reseat the ball **B**. The trapped oil flows from chamber **G** through by-pass ducts **H** to the spout

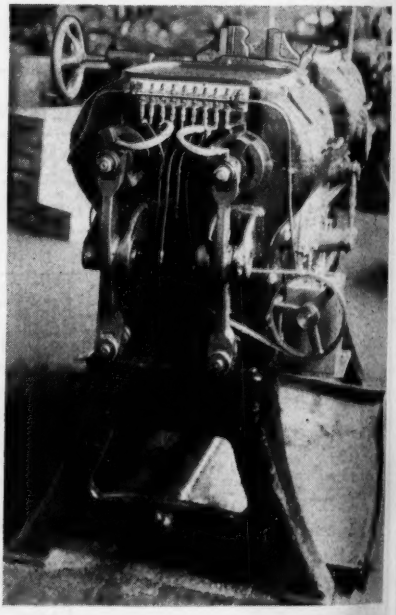

Fig. 3—Blanchard Pulsolator in operation on a Warner & Swasey chucking machine.

I where it drips off in view of sight glass J and thence by gravity to the bearings. Feeders may be arranged singly or in gangs up to 24, or more, if required.

It is important to note that the oil is forced upwards from passage A through the measuring feeder; thus preventing any chances of sludge or sediment collecting in the ball seat L. Also that "jump" action of the pulsation pressure creates an activity in the seat which overcomes any tendency of the metering ball to stick or for foreign matter to accumulate.

Auburn Multiple Groove Ball Thrust Bearing

The Auburn Ball Bearing Co., 77 Clarissa St., Rochester, N. Y., has brought out a bearing known as the Multiple-Groove type of Ball Thrust Bearing. The bearing is designed for those conditions where a heavy service bearing is required for loads greater than a single groove bearing will carry.

The increase in bearing capacity is obtained by adding additional rows of

Auburn Multiple-Groove Ball Thrust Bearing

balls. The outside diameter of the bearing is thus made larger, but the thickness with each additional row of balls remains constant. This is a desirable feature when the allowable space for the bearing thickness is limited, but where a larger outside diameter can be used.

Large diameter rotating machine parts having an adequate journal bearing support are steadied in their operation, and improve with this type of bearing. Auburn Multiple Groove Thrust Bearings are made in two-row, three-row and four-row style, from 1½ in. to 26 in. outside diameter in standard and special sizes.

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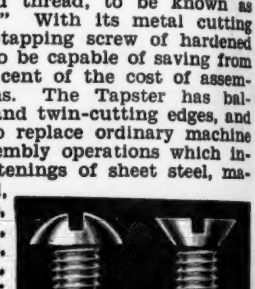
"The most widely read metalworking magazine in the world."

The "Tapster" Self-Tapping Screw

The Kellogg Switchboard & Supply Co., 1068 W. Adams St., Chicago, Ill., is now offering to the trade a self-tapping screw with standard thread, to be known as the "Tapster." With its metal cutting tip, this self-tapping screw of hardened steel is said to be capable of saving from 40 to 75 per cent of the cost of assembly operations. The Tapster has balanced flutes and twin-cutting edges, and is designed to replace ordinary machine screws in assembly operations which include the fastenings of sheet steel, machinery steel, brass, bronze, aluminum, die - castings, fiber, slate, ebony asbestos, bakelite and similar hard materials. The use of the "Tapster" entirely eliminates tapping and its accompanying expense and loss of time.



"Tapster" Self-Tapping Screw

The feature of the "Tapster" is primarily its standard thread and twin grooves with cutting edges. The "Tapster" does not simply push the metal aside; it cuts a clean thread just as a tap would. Consequently, since it cuts a thread to exactly fit its own thread, the fit is practically perfect. This means that the assembly will have greater strength in resisting stress, sheer and vibration. The Tapster can be retracted and redriven without injury to itself or the threaded hole. As the Tapster is made with standard thread, lock nuts can be used wherever required. Made in the same dimension and with the same standard thread as a conventional machine screw, the Tapster can be replaced without difficulty or loss of time. It is available in all standard sizes with standard heads as well as in any plated finish with special head.

Advertisers like to know whether or not their advertisements are being read. When inquiring about machines, tools, or equipment advertised in this magazine, please mention MODERN MACHINE SHOP. Your cooperation will help to build up a bigger and better magazine for your own benefit.

DIAMOND FLEXIBLE COUPLING. Catalog II, presenting the Diamond Flexible Coupling, made by the Diamond Chain & Mfg. Co., 459 Kentucky Ave., Indianapolis, Ind., contains full information, tables of dimensions, and illustrations of the coupling in use. Chapters deal with the selection of couplings, standard specifications, engineering service, and directions for installing the couplings. Copy free upon request.

FAFNIR CATALOG, No. 17, issued by The Fafnir Bearing Company, New Britain, Conn., combines all of the information and the industrial uses of radial ball bearings as well as the Fafnir power transmission line of wide inner ring and ball bearings. It gives complete information, interchangeability tables, dimensions, prices, in fact every type of information except detailed engineering and application data. It treats of single row radial, double row, radial thrust, grease shield, felt seal, thrust wide inner ring, pillow blocks, lineshaft boses and cartridges. Copy free upon request.

Motion Economy

(Continued from Page 14)

ception, this law may be applied with uniformly good results.

Law No. 6. Materials and tools should be located to permit the best sequence of therbligs.

In the cap screw and washer assembly the operator lifts the assembly from hole B and drops it in delivery chute D, then continues the motion without interruption or much change of direction to bin No. 1 to secure a rubber washer. This gives a much better sequence of therbligs than would have been the case, for instance, had the rubber washers been located in bin No. 4. Having determined the best sequence of therbligs or cycle of motions, tools and materials should be studied with reference to their place in this cycle of motions and located at the work place in the most convenient manner.

(Continued in the April issue)

"Parkerizing—the Parker Process of Rust-Proofing" is fully explained in a 32-page, 8½ x 11-inch book that is being distributed to industry by the Parker Rust-Proof Company, Detroit, Michigan.

Ordinary iron and steel are the least permanent of metals. Iron ore closely resembles common rust; in fact, there is very little difference between the two. The rusting of iron is the tendency of the metal to return to its original state.

"Parkerizing" is a chemical process which changes the character of the original surface of the metal to phosphates which are insoluble in water and permanent in the air, thus precluding the possibility of rust. This book explains the "Parkerizing" process and the manner in which it is applied, the text being amplified with photographs of Parkerizing installations and various kinds of metal products upon which the Parkerizing process is used.

This book should be of prime interest to every manufacturer of metal products. Copies will be sent to mechanical executives upon request.

Did You Know That---

You can quickly make an extension for use with straight shank drills in deep holes? See page 51.

Flexible shafts should be run at the highest possible speeds? See page 33.

Rhythm is an important factor in hand operations? See page 12.

Your dial indicators can be reconditioned at a very low cost? See page 57.

A book telling you what you want to know about grinding wheels may be had for the asking? See page 49.

You can convert your milling machine into an engraving machine by using a small electric attachment? See page 55.

The full benefits of modern machinery cannot be realized unless served by modern material-handling equipment? See page 17.

The new front wheel suspension automobile presented a new grinding problem to industry? See page 19.

A "non-skid" belt is now being made which eliminates the need for belt dressings? See page 27.

Flat annealed and accurately-ground stock in handy sizes for dies, gages, and templets is now available? See page 31.

Complicated problems, inverse proportion, "trig", logarithms, and so on can be solved almost instantly by the use of a small, inexpensive slide rule? See page 91.

A really modern automatic lubricating system for machine tools is now available? See page 78.

A machine can be had in which rotating parts can be tested for unbalance without removing them from the machine? See page 77.

For Your Catalog Library

Check any of these useful publications that you want, write your name, firm name, title, and address on the margin, then tear out the page and send to Modern Machine Shop, 128 Opera Place, Cincinnati, Ohio. They will be forwarded to you promptly without cost or obligation. Please restrict your list to not more than five.

Cut Your Sawing Costs: "Lenox" hack saw blades and band saws are guaranteed to effect savings on your sawing operations. Write for information to American Saw & Mfg. Co., Springfield, Mass.

Ames Dial Gages: Dial gages, gage heads, cylinder gages, dial thickness gages, dial micrometers, and special gages and attachments made by the B. C. Ames Company, Waltham, Mass. are described and illustrated in Catalog 50. Write for copy.

Scrape by Power: Bearing surfaces can be scraped with a power scraper that is quicker and easier than the antique hand method. Write for information to Anderson Bros. Mfg. Co., 1926 Kishwaukee St., Rockford, Ill.

Stop Tap Breakage: A booklet that tells how to stop the breakage of taps, reamers, and other tools, by the use of a friction chuck, also how to use the chuck for setting studs or nuts, has been issued by The Apex Machine & Tool Co., 200 Davis Avenue, Dayton, Ohio. Sent free upon request.

Machine Shop Accessories: Catalog B-27, issued by the Armstrong Bros. Tool Co., 828 N. Francisco Ave., Chicago, Ill., describes the line of tool holders, boring tools, wrenches, pipe tools, ratchet drills, lathe dogs, and other tools manufactured by this company.

A New Deal in Hacksaw Blades: "Blue End" Hacksaw Blades reduce costs by cutting faster and lasting longer. Write for data and prices to E. C. Atkins & Co., 402 S. Illinois St., Indianapolis, Ind.

"Atlas" Bench Lathe: A 9-in. screw cutting, self-contained, motor-driven bench lathe is now being built by Atlas Press Co., Kalamazoo, Mich. Write for circular.

Correctly-Designed Ball Bearings: The Auburn T-114-RG Ball Thrust Bearing does the work of a large bearing at a minimum of cost. Write Auburn Ball Bearing Co., 69 Clarissa St., Rochester, N. Y.

Arbor Presses in 64 types and styles are described and illustrated in a catalog that can be had by writing Edwin E. Bartlett Co., Nashua, N. H.

"Ground-From-The-Solid" Taps: Bath taps are hardened in the solid, then the teeth are generated by grinding, producing absolutely accurate taps. Write for the "Ground Thread Handbook", free. John Bath & Co., Inc., Worcester, Mass.

Drop Forged Steel Die Sets: The economy and other advantages of drop forged steel die sets, which are now being made by E. A. Baumbach Manfg. Co., 1806 South Kilbourn Avenue, Chicago, Ill., are explained in a folder that can be had by addressing this firm.

Gears, Sprockets, Speed Reducers, of all types and in all sizes are described in Catalog M-56, issued by the Charles Bond Company, 617-623 Arch St., Philadelphia, Pa. Ask for copy.

Bradley Precision Micrometers, of new design, accurate, are now being marketed by Bradley Machinery Co., 6502 Epworth Blvd., Detroit, Michigan. Write for information.

Brighton Safety Set Screws provide an important factor of safety. No heads to project. The Brighton Screw & Mfg. Co., 1450 Harrison Ave., Cincinnati, Ohio.

Fine Tools of All Kinds are described and illustrated in a new catalog that has been issued by Brown & Sharpe Mfg. Co., Providence, R. I. Copy free.

Buckeye Pneumatic and Electric Tool — drills, grinders, nutsetters, screwdrivers, polishers, buffers and other tools are fully described in the "Hercules" Catalog. Write for copy to The Buckeye Portable Tool Co., Dayton, Ohio.

645 Stock Sizes of Bronze Bushings are listed with dimensions and prices in the Buckeye Stock List "G". Write for it. Buckeye Brass & Mfg. Co., 6410 Hawthorne Ave., Cleveland, Ohio.

Bushings and Bearings: 500 sizes of finished bronze bushings that are available immediately are shown in a catalog that can be had by writing to The Bunting Brass & Bronze Co., Toledo, O.

"The Inside Story" is the title of a book that will tell how hard castings can be machined, scrap reduced, and tool costs cut by the use of Carboloy. Write for copy to Carboloy, Inc., 2485 E. Grand Blvd., Detroit, Michigan.

Grinding Wheels—Aloxite and Carborundum Brand—are of uniform structure, are properly balanced in composition of grain and bond, in bond density, and in grain treatment, resulting in wheels that cut keenly, cut with speed, and that give the maximum of wear. Write for data to The Carborundum Company, Niagara Falls, N. Y.

"Circle R" Saws for cutting metal, made in both carbon and high speed steels, from ¼ in. to 10 in. in diameter, are now available. Write to Circular Tool Co., Inc., 767 Allens Ave., Providence, R. I. for catalog.

"Hypro" Planers: The most modern engineering practice is incorporated in the design of Cincinnati "Hypro" Planers, made by the Cincinnati Planer Co., Oakley, Cincinnati, Ohio. Write for catalog.

Balance Your Parts the Micro-Poise Way: Vibration can be removed from flywheels, fans, wheels, and other rotating parts by eliminating dynamic unbalance. Ask Commerce Pattern Foundry & Machine Co., 2213 Grand River Ave., Detroit, Michigan, for full information.

Centerless Grinding: A high-speed service at low cost. If you have cylindrical parts to be ground, send blue-prints for estimates to Commercial Centerless Grinding Co., 6538 Carnegie Ave., Cleveland, Ohio.

Motorize Your Cone Pulley Lathes: An attachment that can be applied to your lathe with four bolts makes it possible to motorize and modernize your lathes. Write for information to Cullman Wheel Co., 1336 Altgeld St., Chicago, Ill.

Davis Keyseaters: The newest methods of keyseating are discussed in a bulletin that also describes and illustrates the keyseating machines made by the Davis Keyseater Co., 250 Mill St., Rochester, N. Y. Copy free upon request.

Delta "Hand Milling Tools": The features that entitle Delta files to be called "hand milling tools" are discussed in a booklet that can be had by addressing The Delta File Works, 4837 James St., (Bridesburg), Philadelphia, Pa.

Grinding Wheel Dressers: All of the different types of grinding wheel dressers made by the Desmond-Stephan Mfg. Co., Urbana, Ohio, including Desmond-Huntington, Desmond-Sherman, Zig-Zag, Diamo-Carbo, and diamond dressers, are described and illustrated in a catalog that has been published by the firm mentioned. Free upon request.

Assemble by Power: A power screwdriver that will set and screw in machine screws at a rate of from 400 to 500 screws an hour is described in a folder that can be had by writing to the Detroit Power Screwdriver Co., 5365 Rohns St., Detroit, Mich.

Steel Spacing Washers: Milling jobs can be set up quicker by using standard spacing washers, made by Detroit Stamping Co., 1345 West Fort Street, Detroit, Michigan. Write for information.

Your Drive Problems will be solved much easier if you have available the wealth of information contained in Diamond Catalog No. 583. Ask Diamond Chain & Mfg. Co., 459 Kentucky Ave., Indianapolis, Ind.

Cut Your Sawing Costs with Disston Inserted-Tooth Metal Saws. Manual explaining features of construction, advantages of design and outstanding results obtained can be had by writing to Henry Disston & Sons, Inc., 321 Tacony, Philadelphia, Pa.

Special Quills for Precision Grinding, made by The Dumore Company, 28 Sixteenth St., Racine, Wis., are described and illustrated in a booklet that can be had by addressing the firm mentioned.

Edgemont Expanding Clutches for countershafts and similar applications are described in full in Catalog H, issued by The Edgemont Machine Co. Inc., Dayton, Ohio. Copy free.

"Speed" Spot Welders for welding metals from 0.0005 in. to ⅝ in. thick are described in a catalog that can be had by addressing Elsler Electric Corp., 761 South 13th Street, Newark, N. J.

Accurately-Cut Gears of all kinds, types, and sizes can be had on short notice from Farrel-Birmingham Co., Inc., 381 Vulcan St., Buffalo, N. Y. Catalogs and engineering data on request, or submit your specifications for quotations.

Precision Measuring Instruments: The latest types and models of dial indicators, thread lead test gages, pitch gages, dial comparators, and other precision gages made by Federal Products Corporation, Providence, R. I., are described in a booklet that will be sent free upon application.

Performance Data On Swiss Jig Borers: This 36-page pamphlet shows various types of jobs from a power shovel turntable jig to a television disc, drilled and bored on Societe Genevoise High Speed Precision Borers, giving data as to size of holes, accuracy and time savings. Free upon request to The R. Y. Ferner Co., 1008 K Street, N. W., Washington, D. C.

Ford Rotary Files. M. A. Ford Mfg. Co., Davenport, Iowa, is issuing a catalog showing, in addition to the complete line of Ford Rotary Files, illustrations of rotary files in use on various kinds of job. Write for copy.

Drilling Machines of modern design—single spindle, gang, high speed, and radial types—are described and illustrated in a catalog that will be sent upon request. Address The Fosdick Machine Tool Co., Cincinnati, Ohio.

Formica Silent Composition Gears: A booklet telling about the uses and advantages of Formica Silent Shock-Absorbing Gears, and containing a fund of valuable data with rules and tables for laying out, cutting, and using gears can be had by addressing Formica Insulation Co., 4632 Spring Grove Ave., Cincinnati, O.

Stampings of any kind or size can be obtained from Greding Brothers, 5 East Third Street, Cincinnati, Ohio. Write for particulars.

Tool Grinding Costs can be cut by using the "Economy" face milling cutter. Write to J. E. Freyman & Sons, 3627 Keswick Road, Baltimore, Md., for information.

Tool Chests: Fine tools should be protected against damage or theft, and the best way is to keep them in a fine tool chest. Write "Gerstner Tool Chests"' 1227 Columbia St., Dayton, Ohio, for catalog of fine chests.

Constant-Level Oilers will keep your electric motors properly oiled with a minimum of care. Write for details to Gits Bros. Mfg. Co., 1847 S. Kilbourn Ave., Chicago, Ill.

"Tools That Go and Go" is the title of a catalog describing and illustrating the milling cutters, inserted tooth cutters, railroad work cutters, expansion reamers and mills, thread hobs, and other cutters made by Goddard & Goddard Company, 12280 Burt Road, Detroit, Mich.

3-Speed Riveters designed for high production and hard service over a long period of time are fully described in a catalog that will be sent upon request to Grant Mfg. & Machine Co., 96 Silliman Ave., Bridgeport, Conn.

Cut Your Die Costs by using a continuous filing machine. Write to Grob Brothers, West Allis, Wis., for information and prices.

Variable Speed Grinding and Polishing Machines: will produce better work at lower costs. Write for catalog of polishing and grinding equipment to Hammond Machinery Builders, 1615 Douglas Ave., Kalamazoo, Mich.

"Haskins" High Speed Tappers will tap your holes at highest speeds, with tap breakage practically eliminated. Tapping speeds up to 3,000 r.p.m. Write R. G. Haskins Co., 4667 West Fulton St., Chicago, Ill.

Your Lathe is a Precision Grinder when equipped with a "Hisey" Wide Range Precision Grinding Attachment. Full details in Bulletin 47M. Write The Hisey-Wolf Machine Co., Cincinnati, Ohio, for free copy.

Precision Bench Lathe Work can only be done on finely-built, accurate machines. The complete line of Hjorth Precision Bench Lathes is described and illustrated in a catalog that has been issued by Hjorth Lathe & Tool Company, 60 State Street, Boston, Mass. Copy free upon request.

Every Machine Shop Should Have a Welding Outfit: Welding is the most modern of metal working operations. An Arc Welder's Manual, containing information on the use of the arc welder, can be had free by writing to Hobart Brothers, Box ME-103, Troy, Ohio.

Vim Tred—"The Non-Skid Belt" is the title of a 16-page booklet describing a belt that describes a new type of belting. Ask for copy. Address E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa.

Pyrometers: Inexpensive portable and stationary single unit and multi-circuit pyrometers are described in a catalog issued by Illinois Testing Laboratories, Inc., 146 West Austin Avenue, Chicago, Ill. Copy free upon request.

Solve Your Tapping Problems with a Jarvis Tapper. Tapping devices for every type of job. Write The Charles L. Jarvis Co., Gilderaleeve, Conn., for information and prices.

Diamond Tools for dressing grinding wheels can be obtained from E. Karelson, Inc., 15 West 44th St., New York, N. Y. Also dressers reset and resharpened. Write for information.

Cams—Any Style—Any Size—up to 50 inches can be had from Kux-Lohner Machine Co., 2147 Lexington St., Chicago, Ill. Write for data.

Threading Machinery: Complete catalogs of individual bulletins covering the pipe threading and cutting machines, bolt threading machines, or die heads made by Landis Machine Co., Waynesboro, Penna., may be had upon request from this firm. State size and type of machine or die head.

Air-Operated Work-Holding Devices: A booklet showing how air-operated chucks and devices of various kinds can be applied to different kinds of machines to save time and labor has been issued by The Logansport Machine Co., Logansport, Ind.

L-R Flexible Couplings are simple, resilient, reversible. Only three parts. Write Lovejoy Tool Works, 303 West Ohio St., Chicago, Ill., for information.

"Last Word" Indicators, built for accuracy, adaptability, and dependability are described in a circular that can be had by addressing H. A. Lowe Co., 1875 East 66th St., Cleveland, Ohio.

Magnolia Bronze Bar Stock, semi-finished and outside in S. A. E. specifications is now available. Write to Magnolia Metal Company, Elizabeth, N. J., for folder.

McCrosky Block Boring Bars: A new and improved method of accurately locating and locking the block in the bar provides any desired amount of float, with a new method of taking cutting thrust. Ask McCrosky Tool Corporation, Meadville, Pa., for Bulletin 12-D.

Time Study Watches, built for accuracy and service are described in Folder No. 3, issued by A. R. & J. E. Meylan, 266 West 40th St., New York, N. Y. Ask for copy.

Magic Chucks: Instantaneous change of tools without stopping the machine spindle can be accomplished by the use of Modern Magic Chucks, made by the Modern Tool Works, Rochester, N. Y. Write for descriptive booklet.

An Electrically-Operated, Full Automatic Lathe—the newest development in machinery for manufacturing purposes—is described and illustrated in a book that can be had without charge by writing to The Monarch Machine Tool Co., Sidney, Ohio.

"Practical Machinist's Guide". A handy shop manual, containing tables of tapers, speeds and feeds, instructions for grinding twist drills, thread dimensions, tap drill sizes, and other useful information can be had by writing to Morse Twist Drill & Machine Co., Dept. 32, New Bedford, Mass.

Compound Spot-Facing Tool: A spot-facing tool retracting, serrated roughing cutters and fixed finishing cutters in the same tool will break up the scale easily and do accurate work. Write for bulletin to Mummert-Dixon Co., 120 Philadelphia St., Hanover, Penna.

Mill Keyseats with a Drill Press: A special attachment that can be applied to a drilling machine for milling keyways is now being made by National Machine Tool Co., 2271 Spring Grove Ave., Cincinnati, Ohio. Ask for circular.

Reduce Equipment Expense: Nicholson Expanding Mandrels will save on your equipment investment and will insure a mandrel for holes of every size from ⅛ in. to 7 in. Write for details to W. H. Nicholson & Co., 136 Oregon St., Wilkes-Barre, Po.

Ball and Roller Bearing Data Sheets: A complete set of data sheets showing all the dimensions and loads at given speeds, and giving instructions for mounting precision ball bearing and Hoffmann roller bearings, can be obtained without charge by addressing the Norma-Hoffmann Bearings Corporation, Stamford, Conn.

Stamp with Numberall: The complete set of figures or letters all combined in one tool, preventing loss of single letters or digits. Write for catalog. Numberall Stamp & Tool Co., Huguenot Park, Staten Island, N. Y.

Speed Reducers: Speed Reducers to obtain any desired reduction up to 24,000 to 1 are described and illustrated in Catalog 29-A, issued by The Ohio Gear Co., 1335 East 179th St., Cleveland, O. Copy free upon request.

Die Making Machines: How dies, templates, gages, etc., can be sawed out, filed, and lapped easily and accurately on Oliver die making machines, is fully described in a bulletin issued by the Oliver Instrument Company, 1430 Maumee Street, Adrian, Mich. Mailed upon request.

Automatic Polishing and Buffing Machine, designed by roduction specialists and built according to the latest principles of engineering, will polish work uniformly and economically. Write for information to The Packer Machine Co., Meriden, Conn.

17 Years of Research in Rust Proofing are incorporated in the information contained in a book on "Parkerizing", issued by Parker Rust-Proof Co., 2204 East Milwaukee Ave., Detroit, Mich. Ask for copy.

Good Gears of all kinds—spur, spiral, bevel, worm, hypoid—in fact any kind or type of gear desired, large or small, machined to an excellent finish and the highest degree of accuracy may be obtained from Perkins Machine & Gear Co., 151 Circuit Ave., Springfield, Mass. Write for estimates.

Reduce Grinding Costs: Let the Porter Machine Co., 3120 Forrer Ave., Cincinnati, Ohio, grand your straight cylindrical, shoulder, and profile surface work by the centerless method at low cost. Send blue prints for quotations.

Production No. 601 Machine for sanding, surfacing, polishing, burring; leaves a straight line finish; eliminates hand labor. Write Production Machine Co., Greenfield, Mass., for illustrated folder.

Heat Treating by Specialists: Have your heat treating done by specialists better, quicker, and cheaper than you can do it yourself. Send specifications for estimates and quotations to The Queen City Steel Treating Co., 436 Oliver St., Cincinnati, Ohio.

Foot-Controlled Air-Valve: Air-operated equipment can now be controlled by valves that are operated by the foot, leaving the hands free to operate the machine. Write for information to the Ross Operating Valve Co., 6488 Epworth Blvd., Detroit, Michigan.

Rotor Air Tools: The latest types of air-operated hand tools for grinding, polishing, drilling, and other similar operations are described and illustrated in a 24-page book that can be had by writing The Rotor Air Tool Company, 5704 Carnegie Ave., Cleveland, Ohio.

Cut small gears, pinions, ratchets, automatically. An automatic hobbing machine for small work, with magazine feed, is described in Catalog WMI, issued by Geo. Scherr Co., 130 Lafayette St., New York, N. Y. Write for free copy.

Simonds Files: A useful book on files showing the various styles made, their uses, cross-section, and cuts, and containing a number of reference tables and other information useful in a machine shop can be had by addressing Advertising Dept., Simonds Saw & Steel Co., 470 Main Street, Fitchburg, Mass.

Lathes for Production or Maintenance. Catalog No. 94, issued by the South Bend Lathe Works, 309 E. Madison St., South Bend, Ind., describes and illustrates the complete line of back-geared screw-cutting engine lathes built by this firm. Ask for a copy.

You can harden and temper tools and small parts correctly and economically by using an "Electroblast" high speed muffle furnace. Ask Stark Tool Company, Waltham, Mass., for complete information and details.

The Live Center you have been Looking For: The Sturdimatic Live Center has eight outstanding features; just what you have been looking for. Ask for bulletin and prices. Sturdimatic Tool Co., 5222 Third Ave., Detroit, Mich.

Cutting and Grinding Facts: A discussion of cutting oils and lubricants, together with descriptions and illustrations of various kinds of jobs upon which cutting oils are used, is contained in a booklet that is issued by the Sun Oil Company, 1608 Walnut Street, Philadelphia, Penna. Free upon request.

Sutton "Sur-Grip" Collets with Diamond Serrations are fully described in a folder that will be sent without charge upon application to Sutton Tool Company, 2842 W. Grand Blvd., Detroit, Mich.

"Midget" Five-in One Slide Rule is a combination of Mannheim, Polymetric, Log-Log, Binary, Add and Subtract Slide Rule. Is 4 in. diameter, gives equivalent of 12-in. rule. Write to Tavell Sales Co., 21 West Broadway, New York, N. Y., for catalog and prices.

Your Arbor Press is a Keyway Cutter when it is equipped with Threadwell Keyway Cutting Tools. Simple, economical. Write for bulletin. Threadwell Tool Co., Greenfield, Mass.

Chuck With Air: How time and labor can be saved by the use of air-operated chucks, cylinders, and other equipment is told in a book which describes "Hopkins" Air-Operated Equipment. Published by The Tompkins-Johnson Company, 620 N. Mechanic St., Jackson, Mich. Sent free upon request.

Protection and Beauty can be added to the selling points of your product by applying a metal coat of Udylite-Cadmium. Ask Udylite Process Co., 3939 Bellevue Ave., Detroit, Michigan, for complete information as to equipment required, methods, costs, etc.

Steels for shafting, manufacturing, and all other purposes where cold finished steels are required can be had in a wide range of sizes, ready for use. Ask Union Drawn Steel Co., Massillon, Ohio, for name of nearest distributor.

Multiple Drilling With a Single-Spindle Drill: Methods by which multiple drilling may be done on a single-spindle drill, using multiple spindle drill heads, are discussed in a bulletin that is issued by The United States Drill Head Co., 1954 Riverside Drive, Cincinnati, Ohio.

Electrically-Driven Portable Tools: The "U. S." line of electric drills, die grinders, surface grinders, toolpost grinders, and bench and floor grinders is described in Catalog No. 33, published by The United States Electric Tool Co., 2471 West Sixth Street, Cincinnati, Ohio. Copy free.

Routing, Engraving, Filing, Grinding can be done on your milling machine, equipped with a Universal High Speed Milling Head. Ask Universal High Speed Tool Co., 647 West Washington, Chicago, Ill., to send one on trial or send descriptive folder.

"Extra Value" Hack Saw Blades: Hack saw blades made of an alloy in which molybdenum is used, and which are said to withstand shock and wear to an unusual degree are now being made by Victor Saw Works, Middletown, N. Y. Full particulars will be sent upon request.

Vincent-Huntington Grinding Wheel Dressers are economical and efficient. Write for folder MS to The Vincent Steel Process Co., 2432 Bellevue Ave., Detroit, Michigan.

Waltham Cylindrical Sub-Presses may be adjusted for wear and perfect alignment can be maintained. Booklet on Sub-Presses and Dies can be had by addressing Waltham Machine Works, Waltham, Mass.

Toolmakers' Tool Chests: The complete line of fine tool chests for toolmakers and machinists made by J. M. Waterston, 420 Woodward Ave., Detroit, Mich., is described in Catalog No. 25. Write for it.

Expanding Mandrels Will Solve your Problem: A set of 12 "Champion" Expanding Mandrels will fit any hole from ½ in. to 6½ in. Write for details to The Western Tool & Mfg. Co., Springfield, Ohio.

Power Drive in Any Position: The modern flexible shaft makes it possible to drive all kinds and types of tools in places and positions impossible of access with straight-shaft machines. Ask The S. S. White Dental Mfg. Co., Industrial Division, 150A West 42nd Street, New York, N. Y., for the "Flexible Shaft Handbook." Copy free to any mechanical executive addressing this firm on his firm letterhead.

Your Own Power Plant is contained in a Witte engine. Oil or gas. No expert operator needed. Write Witte Engine Works, 1723 Oakland Ave., Kansas City, Mo., for catalog.

GRANT NOISELESS RIVET-SPINNING MACHINES. A method of heading rivets which is said to be not only absolutely noiseless but also faster and more satisfactory in every way than hammering is described in detail in a bulletin that has been issued by The Grant Manufacturing and Machine Co., 96 Silliman Ave., Bridgeport, Conn.

Instead of hammering, the rivets are headed by spinning, using a machine which is similar in design to the usual type of riveting machine. The spinning action leaves the rivet head highly polished and with no marks of the riveting tool. The speed of the operation is limited only by the speed with which the work can be handled. A wide variety of spinning machines are illustrated and described in the bulletin. Copies free upon request.

MACHINE GAS CUTTING. This book issued by the Air Reduction Sales Company, 60 East 42nd St., New York, N. Y., has been produced to acquaint the metal-working public with the cutting of metal sheets and bars by the use of an automatic machine in which the tool used consists of an acetylene cutting torch. The book contains 92 pages 8½x 11 inches in size, featuring the Airco "Radiagraph", "Camograph", "Oxygraph", and the "Tramograph"—all of which are products of the above-mentioned company.

The opening chapter consists of an "interview" in which all the questions relating to the use and advantages of gas-cutting equipment are asked and answered in detail. The balance of the book consists of descriptions of a variety of jobs upon which machine gas cutting is used, with data regarding the performance.

In addition to complete descriptions of the machine enumerated above, the book is profusely illustrated with photographs of the machine at work, pieces that have been cut with these machines, and products of all kinds that have been fabricated by the use of machine gas cutting. The pieces shown include gates for a hydroelectric dam, blast furnace top ring and dome, machine tool beds, bell buoys, boiler headers, gear blanks, dies, gear housings, large and small levers, steel plate shapes, and so on. The pictures of the cutting machines in operation show the torches used singly and in multiples of two, three, and four for production work.

A copy of the book is available to any mechanical executive who will address his request on his firm letterhead.

VAN KEUREN PRECISION MEASURING TOOLS. Catalog No. 29, issued by The Van Keuren Co., 12 Copeland St., Watertown Boston, Mass., contains complete descriptions and illustrations of the light wave equipments reference gage blocks, microgage layout tools, plug gages, thread measuring wires, flat and cylindrical laps, surface plates, sine bars, light wave micrometers and other tools made by this firm.

The book should be of especial interest to heads of tool departments or those in charge of inspection. A copy will be sent to any mechanical executive upon request.